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CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II   BROOKLYN, N. Y., APRIL 1, 1914   NUMBER 1

BACKYARD GARDENS

It is possible to have a garden out in the backyard, even if that yard is in poor condition. The very first thing to do toward making a garden is to clean up the yard. All rubbish, all sticks, and large stones must be removed; then the soil conditions are seen just as they exist. City backyards usually have very poor soil. But even in this soil certain seeds will develop and produce fairly good plants.

You need some tools for your work. Your father's spade or spading fork will answer. If it is possible, buy a combination hoe-rake. It is a hoe and a rake combined, and it costs seventy-five cents. Then buy a ten-cent weeder.

Choose the very sunniest spot in the yard for the garden. If this be a first year for gardening, do not attempt to cultivate too large a piece of land. A strip ten by twenty feet is quite large enough for a first attempt. And if your garden soil be very poor, try a plot five by twelve feet.

Border planting is pretty and effective. This sort of planting means that you cultivate a narrow bed all around, or on three sides of the yard close to the fence. The border should be from three to five feet in width.

After the spot is chosen and measured, drive stakes down

into the ground at the four corners, and string a cord about these stakes. The garden is now lined off, so that one may easily keep within bounds where he digs.

The next step in garden-making is to dig up the soil. It should be dug up from six inches to one foot in depth. One foot is not a bit too deep for the digging, but some hard-packed soils are so difficult to work that it is well nigh impossible for any boy or girl to dig so deep as one foot. As the soil is turned over, pick out all the large stones; in fact, remove all stones. Then break up the lumps of soil with the back of your spade or fork. Next rake the soil over and over until it becomes fine. You cannot get it too fine.

Soil should be good and rich for the plants. Part of the food materials that plants use is in the soil. It is wise to add some of these food materials to the soil in order that the plants may thrive. One of the very best sources of these materials is old rotted manure. If there is a stable near your home, see if the owner will give or sell to you some old manure. Be sure to ask for old manure, for if it is not well rotted it will be too fresh for garden use. When too fresh, the manure burns up the little seedling plants. Spread the manure, if you can get it, one or two inches thick over your garden plot, and spade this in. The soil should then be raked over, so that all traces of the manure are invisible to the eye. Street sweepings may be dug into the garden, but if the streets have been freshly oiled, this oil may injure the plants. If it is quite impossible to get any old manure, then buy a little commercial fertilizer. Any seed store has this fertilizer. Bone meal is very good for plants. When you buy commercial fertilizers, remember this, that they are very strong, and you will need but little. For a small garden, twelve feet by five or six feet, two pounds of commercial fertilizer are sufficient. Spread this over the surface of the ground and rake it in.

As soon as you begin to garden, start a nice little compost or fertilizer pile for next year. On this pile dump all the old leaves you can gather, the lawn clippings, and any waste plant material. Put boards over the pile to hold it down, or sprinkle soil on the top. If the pile looks bad in a corner of your yard, just plant a few castor oil beans in front of it, and it is then well screened or

hidden. This compost pile stays outdoors weathering and decaying all winter, and the following spring it is to be added as fertilizer to the garden soil.

After the plot is prepared, planting time is at hand. From the first to the middle of May is a good time to plant, if the ground is warm and the weather fine.

Seeds may be sown in shallow furrows or drills; in groups or hills; or scattered freely over the soil. The first way of planting is the easiest; the last method, the hardest. The second method is used for the planting of corn, melons, cucumbers, beans, and certain other large seed. Most small backyard gardens are laid out in drills for the planting. The drills should be made perfectly straight and extending north and south if possible. Lay a board where you wish to make the drill. The edge of the board is your guide for drill-making. Hold a pointed stick against the board's edge and draw it along through the soil. In this way a fine straight drill is made. You may walk along the board as you plant. In these drills, made from one-quarter to one-half inch in depth, the seed are scattered. Soil should then be covered over the seed and pressed firmly down. Seed will not grow so well if the soil is not firmly pressed against it. The firming of the soil may be done by the foot, lightly treading the soil down.

After the seeds are planted, wait for the young seedlings to appear. When they are two inches high, thin them out; that is, pull up some of the seedlings, so that there is plenty of space between the plants for growth. Stir up the soil between the drills. Do this frequently—three or four times a week. When the surface of the soil is thus stirred, a loose area is formed called a mulch. This mulch holds the moisture in the soil. It is wise not to water your gardens at all unless the weather is very dry and hot. Then water the soil, and not the foliage of the plants. Keep all weeds out of your garden. Weeds choke out other plants. Choose easy plants to begin with, and, after a year's work in a garden, you will be able to try more difficult ones. Plant tall varieties like sunflower and castor oil bean, at the back of the garden. Very low plants, called border plants, should go in front of all the others. Sweet alyssum, ageratum, candytuft, and dwarf marigolds make good border plants. Vines, like morning glory, moon

flowers, and tall nasturtium, should be trained up over a fence, a post, a doorway, or a trellis.

Marigolds, zinnias, corn-flowers, four-o'clocks, sunflowers, nasturtiums, sweet alyssum, candytuft, castor oil bean, scabiosa, and verbena are easy to raise. Flowers should be kept picked or the plants will run to seed-making.

Vegetables easy to cultivate are these: radish, lettuce, bush beans, carrots, onion sets, kohlrabi, beets and corn.

Study the following table. It may be of help in your work:

Vegetable Planting Table

Name	*Depth to Plant*	*Drills apart*	*Plants apart*
Bean (Bush)	2 inches	3 feet	18 inches
Beet	1 inch	1 foot	8 inches
Corn	1½ inches	hills	3 feet
Kohlrabi	½ inch	1½ feet	6–12 in.
Lettuce	½ inches	1 foot	8 inches
Onion (set)	2 inches	1 foot	6 inches
Onion (seed)	½ inch	1 foot	6 inches
Radish	½ inch	8 inches	3 inches
Tomato	1½ inches	hills	3 feet

E. E. S.

NOTICE

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Entrances on Flatbush Avenue, opposite Prospect Park; on Washington Avenue, south of Eastern Parkway; and on Eastern Parkway, west of the Museum building.

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A docent will meet parties by appointment and conduct them through the Garden.

Telephone: 6173 Prospect.

Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

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LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., APRIL 8, 1914 NUMBER 2

THE WILD FLOWER GARDEN

Just the mere thought of a wild flower garden is a joy. All boys and girls would like a bit of Nature's garden in their backyards. The flowers in such a garden are the wild ones. All wild things are hard to tame and wild flowers are no exception. So the problem is one of conquest.

Flowers are like people in that they must be made comfortable if they are to do their best. So you must think of ways to make flowers very much at home, if you expect them to be content and to blossom when taken up out of the woods and brought home to your own backyard. A wild flower garden is the hardest kind of a garden to have, and because of this it is well worth trying for.

If you are planning for such a garden, the very first thing to do is this: go out into your yard and choose the garden spot. If possible, this should be on the north side of the house, a sheltered, shady spot. The wild flowers in the woods are living under conditions of half light or scattered light. The sun comes peeping into the woods through many trees and thick foliage. This sort of lighting is what we call diffused lighting. So do not plan to place your wild flower garden right out in glaring sunlight if you can avoid it. The north side of the house receives fewer numbers of hours of sunshine than the other sides. If there is a little

space tucked into a corner made by a union of two walls choose this. It is a shelter in itself.

After the place is chosen, it must be put into good condition to receive its guests, the wild flowers. The soil ought to be deep and rich. Make a pilgrimage to the woods, taking with you grape baskets, pails, or cigar boxes. These are to hold the fine, rich, black leaf-mold, the soil of our woods. The more of this you can bring home, the better it will make the soil.

Next dig up your garden spot; dig it down one foot in depth and take out the soil. Put the top four inches of soil back into the garden again. It is just as if you had turned your garden soil upside down, only you are not going to use the old bottom soil. This part of the soil, especially in city backyards, is of very little value. The plants obtain many of their food materials from the soil. If you have any old leaves or rotted manure put a four inch layer into the garden. Now on top of this fill in the soil you brought from the woods. Suppose even now the cavity is not filled. In such a case, put back in whatever soil is left. To be sure this will not be a rich top layer. Never mind! The richest soil is in the area where the roots of the wild flowers are to go, and here is where it is really needed.

If it is impossible to bring in enough wood soil for such a bed, try the following plan. Dig over the garden plot and add any richness you can to it. Then place wood soil, or leaf mold, in the immediate spot in which the plant is to go. In this case, you are storing the food materials in definite spots for use, but the entire bed has not been made rich. If the place is too wet where the garden is to be, then put a two inch layer of gravel or small stones in the bottom of the bed. This is called a drainage layer, helping to drain off the water. Many people have the strange notion that wild flowers always live in wet spots. That is not true. Nature looks out for her drainage problems, and does not allow her flower children to be in poorly drained beds, except, of course, the swamp and bog plants, which live in water. Study the conditions under which you find plants growing in the open, and copy these.

When you go out to gather wild flowers for your new garden, take a basket or a big tin or pasteboard box, a trowel, newspapers,

and cord. Wild flowers should be transplanted after they are through blooming. First remove all the larger leaves, so the plant will not wilt, then dig up the plant with roots and a large ball of soil about them. It is well to water the ground thoroughly about the plant before starting to dig. If the roots are injured at all in the lifting, cut the bruised part off. A clean cut will do little harm; a bruised part may decay and that might cause the entire plant to die. After the plant and its ball of soil are dug up, wrap it in moist paper, then dry paper, and pack it away in the box. Take only one plant of a kind. Our wild flowers are precious, and Nature cannot afford to give you more than one of a kind. When you take a plant, jot down in your note book just the conditions under which it is growing. Did you know that plants, like people, seem to enjoy growing near certain others? It is a sort of plant comradeship. Try to give the plant the neighbors it likes, and the light and shade conditions under which you find it growing.

When the plants are gathered, be sure to place them the same day in your own garden. For each plant dig a hole, water this thoroughly, place some rich soil from the woods in the hole, and then set the plant in. Firm it into its new place. Water the plants thoroughly twice a day, morning and evening, for a week or ten days. If plants dry out in the first days after transplanting, they will not live.

Suppose someone finds it impossible to secure a north corner or a very shady one for his wild flowers! What then? In such a case, tuck the wild flower plants here and there in your regular garden. Place one under a shrub, another beneath the foliage of some large plants. Stand off from the garden, notice the spots where the sunlight filters in as it does in the woods, then use these places for the wild flowers. Just study it out. It is a problem worth working over.

There are two big things to work for in wild flower gardening: one is this, try to have one specimen of all the wild flowers in your locality; the other, try for succession of bloom. Succession of bloom means to endeavor to have something blooming in your wild garden all the time. In March the hepatica and spring beauty bloom; wild geranium and dear little bluets appear in April; May is a month rioting in violets, anemones, wake robin,

blood-root, and dog's-tooth violet; bee-balm, bell-flower, and mullein come in June; July is gay with milkweed or butterfly-weed. And so it goes, ending the year with asters and golden-rods, hosts of each. Just one plant of mullein, straight and tall, against a fence, is a charming sight to see. Clumps of daisies, a big clover plant, a few violet roots—think of the grace of it all. Just one little spot in the garden, a nook worth nothing for general gardening, becomes the choicest spot of all. Do not despise the common wayside plant. It adds much to the garden when properly trained.

It would be better to have a wild flower garden at school than at home. Then many boys and girls could enjoy it, and only very few plants would be required. If this is an impossible plan, perhaps all the boys and girls of one neighborhood could have one garden in the yard most favorable for wild flower culture. And always keep this in mind, that it is your duty to protect our native wild flowers, not only by growing them, but also by not destroying them, and by inducing other people not to destroy them by pulling them up by the roots, or by gathering large quantities of them and then throwing them away.

E. E. S.

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ARBOR DAY NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., APRIL 22, 1914 NUMBER 3

TREE PLANTING

Arbor Day in each State is a day set apart for the planting of trees and for the consideration of how valuable trees are to man. The early spring or the late fall are the best seasons for planting those trees that shed their leaves in autumn. Some people prefer spring, others fall, but for most trees that shed their leaves each year it does not greatly matter which of the two seasons is chosen.

The greatest need of trees, as indeed of all plants, is a proper amount of water. Therefore the most important point in transplanting is the water supply. Plants take in water almost entirely from the soil through their roots, while they lose it continually by evaporation from their leaves so long as the foliage remains on. This is why early spring and late fall are the best seasons for transplanting. In early spring the leaves have not yet appeared, so that water is not being lost by evaporation; but the roots are already active, new ones have time to grow, and the entire root system has a chance to become sufficiently established to take in water as fast as it will be lost when the leaves begin to appear.

When trees are transplanted in late autumn, the leaves are falling, or have all been shed, but the roots may continue to grow in the soil for several weeks, before the ground freezes or becomes too cold for them to grow. When spring returns, the roots again become active before the leaves appear, and thus sufficient water supply is insured as soon as the leaves put forth from the opening buds.

Evergreen trees, which never shed all of their leaves at any one time, may be transplanted to advantage in August and September; for, although their leaves remain on, they become less and less active and give off less water as winter approaches. The activity of the roots continues, however, for a longer period, and vigorous enough to supply water as fast as it is evaporated from the leaves. It is claimed by many expert tree movers that if evergreens are transplanted in the spring the leaves are liable to become active, and thus lose water in large quantities before

new roots have had time to form and before the older roots have had sufficient time to become well established in the soil. However, it has been found to be possible in actual practice to transplant evergreens in the spring, and this is commonly done, but it is often an advantage, for several reasons, to be able to move them in the early fall, and so it is well to know that this may be done whenever desired.

Many trees planted on Arbor Day die. This may be due to a great many different causes. But if care be taken in the selection of the tree, in the preparation of the place into which it is to go, and in the care of it after planting, all should go well.

It is wise to choose a tree which is native to the locality in which it is to be planted. When a tree is to be planted on the school grounds, some one always wishes to try some unusual variety of tree. These are often more difficult to make grow than the kinds of trees which belong to the woods nearby, or those you see growing nicely in the park, or as shade trees along the streets. Country boys and girls should choose a little five foot sapling growing in their own woods. City boys and girls have a more difficult problem. The woods are miles away perhaps. So the tree must be bought.

The smoke, dust and pavements of a city are very hard on trees. The smoke and dust interfere with the leaves, and the pavements keep water from the roots. For these reasons, it is necessary to choose for city planting a tree that is hardy, grows easily, and can adapt itself well to these unfavorable conditions.

The table below may be of help in deciding what trees to plant:

Trees good to plant on Arbor Day
FOR NEW YORK CITY AND VICINITY

For City Streets

1. European Linden
2. Oriental Sycamore
3. Norway Maple
4. Red Oak

For Suburban Streets

5. American Elm
6. English Elm
7. Red Maple
8. Ginkgo (Maidenhair tree)

Also Nos. 1-4

For the Lawn

9. Schwedler's Variety of Norway Maple
10. Tulip Tree
11. Dogwood (white or purple flowered)
12. Sweet Gum
13. Copper Beech
14. Magnolia

Also Nos. 1-4, and, in the suburbs, Nos. 5-8

Numerous pines and spruces (especially Koster's blue spruce) make beautiful trees for lawns.

The poplar is a quick growing tree and is often used by real estate men when quick results are desired in sections newly developing. It is, however, a short lived tree, and, for other reasons also, is one of the least desirable of all our trees for streets and lawns.

In handling the tree before it is planted, great care must be taken that the roots do not dry out. Trees that are purchased from a dealer have a good ball of earth around the roots, wrapped in burlap. If you dig up your own tree be sure to keep such a ball of earth about the roots until the tree is planted.

Care should also be taken not to have the bark rubbed off in places, or otherwise injured.

When the new home is to be made ready for the tree, dig a hole wide enough to take in all the roots when spread out. The depth depends on the size of the tree and of the earth ball. The roots of the tree must not be cramped. If the tree is held above the spot where the hole is to be dug and the roots spread out it will be seen just how wide the hole must be. Or if the hole is already dug before the tree arrives, estimate in the same way. People are surprised to see the extent of spread which even a very young tree has.

Look the roots over carefully. If there is a bruised place on roots or rootlet, cut such a place off. Make a clean cut with a sharp knife, not a jagged, ragged one. The bruised place, if left on, may begin soon to decay, and this decay may spread. An entire tree may be lost for just one bruised spot. A jagged cut also is a place where decay may set in.

After the roots are trimmed, pour plenty of water into the hole—at least one or two large pailfuls. Then place a layer of good rich soil at the bottom of the hole, for it is very essential to have next the roots a good supply of food elements. When manure is mixed with the soil, always use old, well rotted manure, as fresh manure gives off a great deal of heat while rotting and this is not good for the roots. Be careful not to have much strong manure close to the roots, especially chunks of it in contact with the roots (fig. 1), as this is liable to cause the roots to decay. To avoid this danger, be sure the manure is well broken up and thoroughly mixed with the soil.

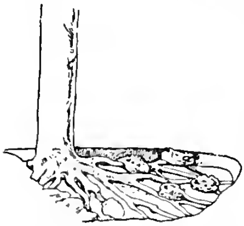


Fig. 1—The wrong way to distribute manure around the roots.

Spread the roots out carefully in the cavity, keeping the larger ones up within about six inches of the surface of the ground, and then fill in the soil (fig. 2). Again remember to put the best soil in first, and press it firmly about the roots. Take a stick with a blunted end or use your fingers for this, and be sure that soil is pressed firmly into the spaces between all the roots and rootlets. Continue filling in until the cavity is full, and then firm (press) the soil with the feet (fig. 3). Do not heap thesoil about the tree trunk, so that the water drains away from

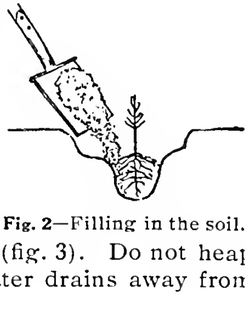


Fig. 2—Filling in the soil.

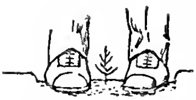


Fig. 3—Firming the soil.

the tree, but rather slope the soil down toward the trunk. The tree should set a little lower in its new place than it did in the old one. A little old rotted manure put on the surface of the soil is excellent for the tree's growth, as it will not only supply fertilizer, but will also act as a *mulch*, retarding the drying out of the soil.

Keep the ground about the tree well watered for two or three weeks, but do not use so much water that it will form a puddle at the bottom of the hole in which the tree was planted, as shown in fig. 4. Roots, as well as leaves and branches, need plenty of fresh air, and if the spaces between the soil particles are filled with standing water, air is excluded, the roots cannot respire, and will soon begin to decay. This will cause the entire tree to die. Many trees planted on Arbor Day are killed by having too much water as well as by not having enough.

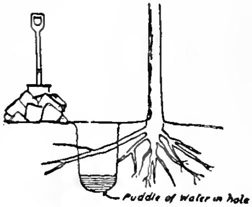


Fig. 4—Too much water around the roots.

All summer long the newly planted tree should be thoroughly watered about once in every two weeks. Do not use a sprinkling can, but pour the water on until the soil is thoroughly wet, and the water begins to sink into the soil more slowly than at first.

On the following day, stir the soil about the tree to a depth of about two or three inches, so as to form a loose layer of surface soil, called a *dust mulch*. This will greatly retard the loss of water from the soil by evaporation, and the tree will get the full benefit of it.

After the tree is planted, it should be supported by being tied to a stake firmly fixed in the ground close to the trunk; and should be protected by a tree guard, or by wire netting placed around it.

E. E. S.
C. S. G.

A TREE CLUB FOR BOYS AND GIRLS

In 1910 was organized The American Association for the Planting and Preservation of City Trees. During the first three years of its existence it was instrumental in securing the planting of nearly 3,000 trees in over twenty localities in Brooklyn. The headquarters of this association are at the Children's Museum of the Institute in Bedford Park.

Any boy or girl who wishes to do so may join the Junior Branch of this association. This branch studies trees, and has raised a fund of about $150 for the planting of trees in our city streets. This fund has all been raised by the boys and girls by selling newspapers, tinfoil, old rubber and scrap iron, and about $100. will be expended this spring for tree planting in neighborhoods and school grounds. Just think how much *three thousand* new shade trees add to the beauty and attractiveness of any city!

There are 3,000 members of the Junior Branch, so there has been planted one tree for each member. Every member has a neat bronze badge to wear, and meetings are held on Saturday mornings at 11 o'clock, at the Children's Museum, in Bedford Park.

C. S. G.

Figures 1-4 above are by courtesy of Isaac Hicks & Son, Westbury. L. I.

E. M. Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., MAY 6, 1914 NUMBER 4

ORNAMENTAL CLIMBERS

It is not necessary to dwell upon the value of ornamental climbing plants as adjuncts to the house and garden; they are valuable not only on account of their intrinsic beauty, but also because of the possibility of employing them as beautiful and effective porch screens, and for their utility as a means of shutting off and covering unsightly objects.

In this LEAFLET it is proposed to give cultural directions which it is hoped, will be of service to those who desire to grow climbing plants, together with a selection and short description of the most suitable subjects.

If the best results are to be obtained it will be necessary thoroughly to prepare the ground before planting. If your soil is naturally good, all that is necessary will be to break it up to a depth of about eighteen inches, afterwards digging in three or four inches of well decayed manure. If, on the other hand, the ground consists mainly of bricks, and rubbish generally, it should be excavated to a depth of two feet and filled in with good soil. If this is not practicable, the next best thing to do will be to remove the bricks and as much of the rubbish as possible, and then work in a liberal supply of well decayed manure. It will be necessary, however, to provide a sufficient amount of fine earth for the purpose of filling around and covering the roots of the plant.

The best time of the year to plant depends upon the kinds to be planted. As a general rule,—referring to those vines of a perennial nature—the fall is the best time to plant the deciduous ones, and the spring for the evergreen kinds, but they may all be planted in the spring if necessity demands it. Care should be taken when planting to make the soil firm around the roots of the plants, and watering must not be neglected until the plants are thoroughly established. The planting of the annual kinds is done in the spring, either with plants raised in the greenhouse, or from seed sown where the plants are to remain.

Another point to bear in mind is the necessity of selecting plants that are suited to the position assigned them. For instance, do not place a shade loving plant where it will receive full sunshine, or vice versa; neither should a rampant growing plant be placed where there is no room for it to attain its full development.

In the list of plants following, their preferences for sun or shade will be indicated, also the nature and extent of their growth. This list must not be taken as being in any way an exhaustive one; it is merely an attempt to select a few of the more desirable subjects.

Perennials

The Silver Vine, (*Actinidia arguta*), is a native of Japan; it produces white flowers in early summer, but is most valuable for its beautiful, dark green, shining foliage. It is a vigorous grower, doing well in sun or partial shade, and is suitable for porch pillars.

Ampelopsis. This genus contains perhaps the most valuable of all climbers for quickly covering walls of any kind: namely, *Ampelopsis Veitchii*, the Boston Ivy; *Psedera quinquefolia*, the Virginia Creeper, is also a well known and valuable plant; *A. Lowii* is a plant similar to the Boston Ivy, but has more deeply cut leaves and is not such a vigorous grower. All of the *Ampelopsis* grow best in full sun, though they will also thrive in partial shade.

The Dutchman's Pipe, (*Aristolochia Sipho*). This is a rank and vigorous grower, suitable for covering arbors, or for any position where a mass of foliage is quickly desired. It produces its oddly shaped and rather inconspicuous flowers in May and June. It is not particular as to location, growing in sun or shade.

The Trumpet Vine, (*Tecoma radicans*), is a desirable plant. The dark red flowers are produced in great abundance during the summer. It is rather slow growing and prefers a sunny position.

Clematis. In order to get the various species and varieties of *Clematis* to give the best results, it is necessary to give a little extra care to their cultivation, especially in the case of the large flowered varieties. They prefer a rich deep sandy soil, which must be well drained, and it is advisable to incorporate a few handfuls of slaked lime with the soil prior to planting. They succeed best in a semi-shaded situation. Some of the best of the large flowered kinds are: "Miss Bateman," white; "Duchess of Edinburgh," double white; "Jackmanni", royal purple; and "Mme. Edouard André", rich crimson. They flower in late spring and summer, and should be pruned back severely in the fall in order that they may produce strong young growth the following spring.

The Mountain Clematis, (*Clematis montana*), produces immense quantities of white flowers in late spring. *C. montana rubens* is a red flowered variety. *C. paniculata*, the Japanese Virgin's Bower, flowers in July and August. *C. virginiana*, a beautiful native plant, blossoms from June to September. Very

little pruning is needed in the case of these last mentioned varieties; all that is necessary is to cut out the weak and straggling wood.

The large flowered varieties of *Clematis* are admirably suited for the embellishment of porch pillars, while the other varieties mentioned, being of stronger growth, are better suited for covering arbors, etc., or for screening unsightly objects.

Euonymus radicans is an evergreen plant well adapted for covering low walls, to which it clings by means of adventitious roots. It has beautiful, dark green leaves and is a desirable plant, especially for shady situations. There are varieties having variegated foliage which are preferred by some people.

Lathyrus latifolius is the Everlasting Pea. It is herbaceous in character and grows from six to eight feet in height. It produces an abundance of blossoms in August. In the type plant the flowers are rosy red in color, but there is also a white variety. These plants prefer a sunny position.

Lonicera. The Honeysuckles are especially desired when a porch screen is desired, on account of the delicious fragrance emitted by them. *Lonicera Halleana* is perhaps the best for this purpose. It is of strong growth, almost evergreen, and produces an abundance of white flowers, changing to yellow, all through the summer. *L. sempervirens*, the Coral Trumpet, is not fragrant, but the scarlet flowers produced in spring and summer are very pleasing. The Honeysuckles grow well in sun or partial shade.

The Kudzu Vine, (*Pueraria Thunbergiana*). When a particularly rampant gropth is required this is the vine to plant. It is a remarkably rapid and vigorous grower and is not particular as to soil or location. It bears purple pea shaped blossoms in late summer.

"Crimson Glory Vine", (*Vitis Coignettiae*). This vine produces wonderful effects in the fall by reason of the brilliant coloring taken on by its foliage. Perhaps it appears to best effect when allowed to ramble at will amongst the branches of an old tree. Its coloring is indescribably gorgeous, and it should be planted by those who have a partiality for "Fall tints."

The Chinese Wisteria, (*Wisteria sinensis*), is a plant well adapted for sunny situations, and produces its panicles of blue flowers in May or June. Sometimes a second crop is obtained in August. The Wisterias live to a great age and well repay liberal treatment in the matter of manure. They should be pruned in summer by cutting back the long, straggling shoots, unless it is desired to extend the plant; in this case, a few of the strongest shoots should be left for the purpose. *Wisteria multijuga* is the Japanese Wisteria, and is reputed to produce panicles of bloom three feet in length.

Annuals

In growing the annual vines, the seeds may either be planted indoors in March or April, or planted directly where the plants

are to grow—usually in May. The following are some of the more desirable of the annual vines:

Balloon Vine, or Love-in-a-Puff, (*Cardiospermum Halicacabum*). This, in spite of its name, is worth growing on account of its interesting seed vessels, shaped like ballons. The flowers are white and insignificant. The seeds should be sown in May where the plants are to flower.

Cup-and-Saucer Vine, (*Cobaea scandens*). This is really a perennial, but for cultural purposes it is usual to treat it as an annual. The seeds are best sown indoors in April, and the resultant plants placed out of doors toward the end of May. The *Cobaea* is of extremely vigorous habit, often making growth thirty feet or more in length. The flowers are dull purplish in color, and there is a variety called *alba*, with dirty white flowers.

Morning Glory, (*Convolvulus major*). These are well known, and can be had in a variety of colors. The seeds, previously soaked in warm water for about twelve hours in order to assist germination, should be sown in May in the position where the plants are to flower.

Cucurbita. Most of the ornamental Gourds belong to this genus. They are coarse vines of the squash type, and are suitable for out-of-the-way corners. The seeds may be sown indoors in April, or outdoors in May in a sunny position.

The Moon Flower, (*Ipomoea grandiflora*.) This plant produces fragrant, white flowers of immense size, which are at their best during the evenings. The hard outer covering of the seeds of this, and all of the *Ipomoeas*, should be cut or filed before they are planted to enable moisture to come in contact with the embryo more readily. Soaking the seeds in warm water overnight will serve the same purpose.

Ipomoea Quamoclit hybrida, is a plant of recent introduction that is well worth growing. It makes a growth of about thirty feet, has beautifully cut foliage, and produces its cardinal red flowers in great profusion.

The Nasturtium, (*Tropaeolum majus*), is too well known to need any description. It will grow practically anywhere and once established will take care of itself from self-sown seed every year. ? A species of *Tropaeolum* that is not so well known is *T. canariense*, the Canary Bird Vine. This is quite distinct from the every day Nasturtium, possessing very ornamental foliage, and yellow flowers which bear a fancied resemblance to canaries. The seeds may be sown in May, in the position where they are to flower.

Two of the most important groups of ornamental climbers have been omitted—the Roses and Sweet Peas. Their importance is such that they can only be dealt with in separate Leaflets.

M. F.

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., MAY 20, 1914 NUMBER 5

INFORMATION FOR TEACHERS ABOUT THE BROOKLYN BOTANIC GARDEN

LOCATION: As shown on the diagram on the last page of this Leaflet, the Garden is situated between Eastern Parkway on the north, Malbone Street on the south, Flatbush Avenue on the west, and Washington Avenue on the east.

ENTRANCES are on Flatbush Avenue at the north and the south ends; on Washington Avenue at the north end, and at the buildings; and on Eastern Parkway, west of the Museum building.

HOURS OF OPENING: The Garden is open daily, from 8 a. m. until sunset; on Sundays and holidays at 10 a. m. Conservatories open, April 1—October 1, 10 a. m.—4:30 p. m.; October 1—April 1, 10 a. m.—4 p. m.

During the present season and until further notice, entrance to the Garden may be had only at the laboratory building on Washington Avenue, on permission from the office. This temporary regulation is made necessary by extensive grading operations and the construction of new paths throughout the grounds.

TO REACH THE GARDEN: *From Brooklyn*, take surface lines to Malbone Street and Washington Avenue; or to Malbone Street and Flatbush Avenue; or St. John's Place surface car to Sterling Place; or Brighton Beach elevated to Consumer's Park station. *The train stops here only when the guard is notified at the preceding station* (Park Place going south from Brooklyn Bridge; Prospect Park, going north toward Brooklyn Bridge).

From Manhattan, take the Brighton Beach elevated at Park Row (Brooklyn Bridge) to Consumer's Park station. *Train stops only when guard is notified at Park Place station.* Time from Park Row about 30 minutes. Or take subway (Brooklyn Express) to Atlantic Avenue, thence Flatbush Avenue (*not* Flatbush-7th) trolley to Prospect Park Plaza for the north-west gate, or to Malbone street for the south-west gate. Time from Park Row about 30 minutes.

BUILDINGS: The laboratory building and conservatories are located on the eastern side of the Garden, near Washington Avenue. Entrance to both structures may be had from either Washington Avenue or through the Garden from Flatbush Avenue or from Eastern Parkway.

USE OF BUILDINGS: Teachers with classes may arrange in advance to hold sessions in the lecture room in the laboratory building, or in the class room in the conservatories. There is a black-board in the lecture room.

EQUIPMENT FOR THE USE OF TEACHERS

LIBRARY: The library is not a circulating library, but is open free for reference every day in the week, except Sundays and holidays. Members of the garden staff will, whenever possible, be glad to give any information concerning botanical literature. Over 65 periodicals on botany or closely related subjects are currently received.

HERBARIUM: The Garden herbarium contains over 104,000 specimens, including spermatophytes and cryptogams, and may be freely consulted by arranging with the curator in charge.

LANTERN SLIDES: The Garden collection of lantern slides numbers at present about 1500, but is constantly growing. These slides cannot be loaned for use outside the Garden, but may be used by teachers holding class exercises in our lecture room, which is equipped with a modern lantern for both transparent and opaque projection.

PLANT MATERIAL: The Garden cannot undertake to supply living plant material in large quantities for class use, but will be glad to receive requests at anytime, for material in small quantities, and these requests will be met to the full extent of our ability to do so. Teachers who wish to grow such material as fern prothalli and seedlings, or to collect fresh water algae from our lake and brook, may obtain permission to do so on application to the curator of public instruction.

LABORATORY APPARATUS: Teachers wishing to set up experiments in the conservatories or elsewhere will be supplied with simple apparatus, such as beakers, test-tubes, flasks, Petri-dishes, etc. Balances for weighing are also available.

INSTRUCTOR: When notice is given in advance an instructor will conduct class exercises on subjects, supplementary to the school work, not regularly included in the high school course, such as plant propagation, or other applied phases of botany.

DOCENTRY: Arrangements may be made for the services of a teaching guide to conduct classes to any section of the plantations or for field lessons in the Garden on any special topic. No special permission or arrangement, of course, is required for teachers who wish at any time to conduct their own classes through the Garden.

SPECIAL LECTURES: On request from any high school teacher a member of the staff will arrange to give at the Garden an illustrated lecture before a class or group of students, on any subject related to the school course in botany, so far as illustrative material for the same is available at the Garden.

SEMINAR AND JOURNAL CLUB: From October to May, inclusive, the Garden staff holds weekly meetings for the discussion of scientific questions. Every second meeting is a Seminar, and this alternates with a Journal Club for the review of current botanical literature. These meetings are from 4-5 p. m. on a day of the week agreed upon in advance. All teachers of botany are cordially welcomed to join and participate in these conferences. Full information will be given on request.

LEAFLETS: The Brooklyn Botanic Garden Leaflets, issued weekly or bi-weekly from April to October, give timely information concerning flowering and other seasonal activities of plants in the Garden, or treat of various phases of plant life. Their aim is to diffuse popular but accurate information, and to create and stimulate a love and appreciation of plants in both children and adults. They are issued free, and any person who wishes may have his name placed on the mailing list to receive them regularly. Teachers who wish additional copies of any issue for class use, or to distribute to pupils or others, will be supplied as long as extra copies are available. For complete sets of preceding series there is a nominal charge of fifty cents plus postage.

FURTHER INFORMATION: The director of the Garden, or the curator of public instruction will be glad to give any further information concerning the Garden, and will warmly welcome any suggestions from teachers or others as to how its educational work may be made to meet more fully the needs of its co-workers in botanical instruction.

MAIL ADDRESS: Brooklyn Botanic Garden, Brooklyn, N. Y.

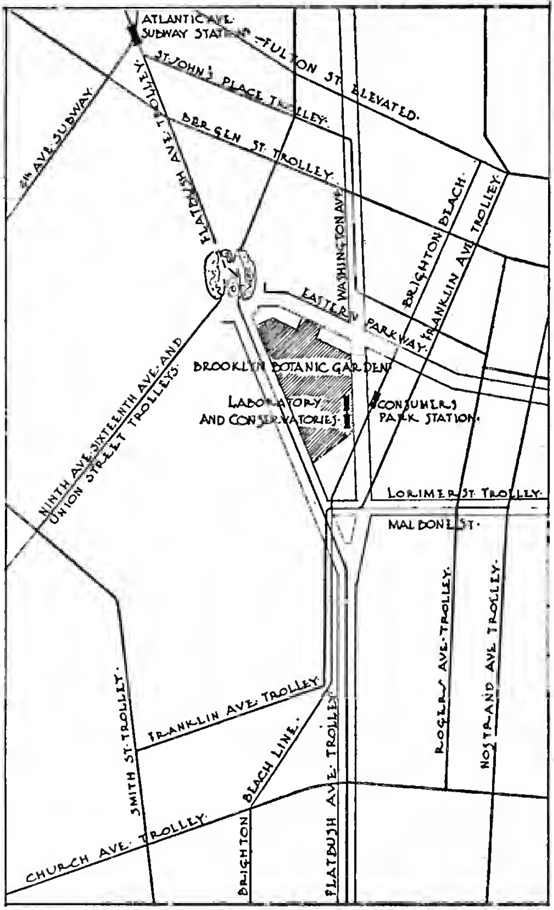
TELEPHONE: 6173 Prospect.

PLANTS NOW IN BLOOM

Among the plants flowering at this season are the following: the horse-chestnut, *Aesculus hippocastanum*, perhaps the best shade tree for lawns. There are trees scattered all along the Flatbush Avenue border mound. A pink-flowered form is also flowering at this time, but there are no specimens in the Garden. Both the common barberry, *Berberis vulgaris*, and a Japanese species, *B. Thunbergi*, are flowering, there being many specimens along the border mounds and in the decorative shrub planting in the local flora valley. Among the thorns many specimens are flowering, notably *Crataegus Crus-Galli* and the English hawthorne, *C. Oxyacantha*. The latter is widely planted and has become the source of more than fifty horticultural forms, many of them of great beauty and usefulness in the shrubbery. Along the local flora shaded path the common crane's-bill and the herb-Robert, *Geranium maculatum* and *G. Robertianum*, are both

flowering, the former having spread and become perfectly at home. *Phlox subulata*, a splendid plant for carpeting rocky places or for dry banks, is now blooming, with magenta flowers that are not popular with some, but which can be used effectively if grouped with harmonious associates. It forms a mass of color in the local flora section. It is found wild in our local flora range only in southern New Jersey and adjacent Pennsylvania, all the numerous stations northward being derivatives, probably of cultivated plants. Most of the azaleas, rhododendrons and laurels that would usually be in flower at this time, will probably be considerably later, owing to the phenomenally cold spring.

N. T.



·LOCATION OF BROOKLYN BOTANIC GARDEN·

CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., JUNE 3, 1914 NUMBER 6

CHILDREN'S GARDEN EXHIBIT

Date: Take out your calendars and mark circles about the dates of September 24, 25, and 26. These circles are to act as reminders, telling you that on these dates there is a Children's Garden Exhibit. The exhibit will be held at the Brooklyn Botanic Garden in the laboratory building and greenhouses. This time is set aside for the boys and girls of the city of Brooklyn to exhibit the flowers and vegetables they have raised.

HOW TO ENTER THE CONTEST

Application: Decide on the class or classes you wish to enter; then make application for blank forms. Blank application forms for pupils and schools entering the exhibit may be obtained in either of the following ways:

1. By sending a self addressed, stamped envelope, with request, to the Botanic Garden.
2. By calling in person at the Botanic Garden office on Washington Avenue.
3. Blanks for all the pupils entering from any one school will, if desired, be delivered to a messenger from that school, calling at the Botanic Garden office.

N. B. Applications may be made only between September 15 and 22.

No more than three entries may be made by any one child. A child whose individual display is entered under C may enter the whole or a part of such display in Classes A, B, or D.

Certification: All exhibits must be certified to. Upon the application blank is a statement to this effect: that all the products exhibited by the contestant were raised by him in his own garden, cared for by said applicant. This statement must be signed by some responsible person such as the school principal, a teacher, parent, or guardian.

CLASSES OF EXHIBITS

All classes are open to any boy or girl residing in the city of Brooklyn, although the garden may be either in Brooklyn or at a summer place.

Class A. *Vegetables*—First and second prizes will be awarded.

No. 1. Beans, Bush.
Best quart of beans in the pod.

No. 2. Beans, Bush.
Best pint of beans, shelled.

No. 3. Beets.
Best bunch of six beets.

No. 4. Carrots.
Best bunch of five carrots.

No. 5. Cabbage.
Best head of cabbage.

No. 6. Corn.
Best six ears of corn.

No. 7. Celery.
Best four plants of celery.

No. 8. Kohlrabi.
Best four.

No. 9. Lettuce.
Best two heads (roots and all).

No. 10. Radish.
Best eight.

No. 11. Squash.
Best one.

No. 12. Tomatoes, Red.
Best six.

No. 13. Tomatoes, Yellow.
Best six.

Class B. *Flowers.* First and second prizes will be given, as in Class A.

No. 1. Ageratum.
Best plant (potted).

No. 2. Asters, White.
Best collection of twelve.

No. 3. Asters, Pink.
Best collection of twelve.

No. 4. Asters, Purple.
Best collection of twelve.

No. 5. Cornflower.
Best collection of twelve.

No. 6. Marigold.
Best collection of eight.

No. 7. Nasturtium.
Best collection of twelve, one or more varieties.

No. 8. Nasturtium.
Best single potted plant or dwarf variety.

No. 9. Scabiosa.
Best collection of eight.

No. 10. Sunflower.
Largest specimen sunflower.

No. 11. Verbena.
Best collection of twelve.

No. 12. Zinnia.
Best collection of eight, one color.

Class C. *School Display*—One prize, a trophy to the school making the best display.

Class D. *Individual Garden Display*—First and second prizes will be awarded for the greatest variety of flowers raised by one child.

When Exhibits must be brought: All exhibits should be brought to the Botanic Garden on September 23, between 9 a. m. and 4 p. m.

Containers: If cut flowers are exhibited, bring a container for each entry. That is, if you exhibit in Class B, No. 8, bring with the flowers a glass bottle, like an olive bottle, to place them in. Bring no container with products under Class A. All vegetables should be washed thoroughly before submitting. Cut off the tops of such vegetables as radish, beet and carrots because these tops wilt badly.

Admission to the Exhibit: Each exhibitor receives a button, which admits him to the Exhibit at any time during the 24th, 25th, and 26th of September.

Award of Prizes: The exhibitors to whom prizes are awarded will receive a card saying "Premium" on it. These cards are to be brought to the Botanic Garden on a day specified and the real prizes will be awarded. The decisions will be made by a committee of judges.

The trophy for Class C will be awarded each year to the school whose pupils in the aggregate have the best exhibits. Any school holding this trophy for three successive years wins it permanently. A new trophy will then be offered.

Aid from the Brooklyn Botanic Garden: Any boy or girl desiring someone from the Botanic Garden to visit his backyard garden this summer to inspect it and offer helpful suggestions, should write to the Brooklyn Botanic Garden and make a formal request.

CARE OF THE GARDEN

Over 5,000 young people have bought penny packets of seeds this year from the Botanic Garden, and with these have planted gardens in their yards or in boxes. Therefore bend all your energies toward making your garden a success.

All summer long a garden needs care. Keep it clean of weeds. Be sure to pull the weeds out root and all. If the roots remain in the ground, the weeds may grow again. If the garden spot is kept clean, pests are not so likely to appear. Another very important thing to remember is this: keep the soil worked up between the rows of plants. Use a weeder, a trowel, or a pointed stick for this work. As the soil is loosened, it forms what gardeners call a *dust mulch*. This mulch acts as a blanket to hold the moisture in the ground. At all times water is travelling up through the sub-soil to the surface of the ground. If the course of the water is not interrupted at this point, it will evaporate off into the air. The dust mulch prevents this surface evaporation, by checking the up-coming moisture in its course. Thus the water is kept in the area where the roots are. Mulching takes the place of watering except in long dry seasons. Do not forget to stir the soil in the garden beds. If it becomes necessary to water the garden, water the plants thoroughly close to the ground, rather than the tops of the plants. Plants take in most of the water they need through their roots and not through their leaves, and when just the mere surface of the soil is watered, then the roots of the plants tend to develop near the surface of the ground. But when the watering is done thoroughly, so that more than the upper layers of the soil are wet, the roots will strike down where water is more apt to be found in time of drought. If the roots and rootlets develop near the surface, as a result of watering the wrong way, their supply of water during a drought will soon fall, and the plants will wilt and die.

As plants bloom pick off the blossoms. Do not allow the flowers to go to seed on the plants. If you wish beautiful and profuse bloom, keep the flowers picked as they open up. Then, too, the plants must have space, for if they are crowded closely in a row, growth is retarded. The following table shows the distances to leave between different kinds of flowering plants.

FLOWER TABLE

Name	*Distance of Plants apart*	*Time of bloom*
Ageratum	4 inches	June to October
Aster	12–15 inches	July to September
Calendula	12 inches	June to October
Candytuft	4–8 inches	June to September
Castor Bean	36 inches	A foliage plant
Cornflower	8 inches	From June on
Four-o'clock	10 inches	July to August
Marigold	6 inches	August to October
Moonflower	6 inches	August to September
Morning Glory	4 inches	July to August
Nasturtium	5–12 inches	July to October
Pansy	7 inches	May to October
Petunia	8–12 inches	July to September
Pink (Dianthus)	5 inches	August
Scabiosa	8 inches	June to September
Sunflower	24–28 inches	August to October
Verbena	12 inches	June to September
Zinnia	8 inches	July to October

E. E. S.

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A docent will meet parties by appointment and conduct them through the Garden.

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Telephone: 6173 Prospect.

Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

Em Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., JUNE 17, 1914 NUMBER 7

VANDALISM TURNED TO ACCOUNT

During the late summer of 1911 some visitors to the Garden took the trouble to girdle one of the birches growing near the shore of the lake. Whether this was done by adults or children, maliciously or thoughtlessly, it is not possible to say.

There are two theories concerning public disregard for public property and for the ordinary rules of conduct, as embodied in regulations governing the use of public buildings and grounds. One theory is that misdemeanors are usually committed without motive, through ignorance or thoughtlessness, and that if people fully sensed the significance of their acts, or realized their own relation to public property—that they themselves are part of the public, and part owners of the property, and are, in reality, injuring themselves when they commit public nuisance—conduct would be regulated accordingly.

Many people, for example, in walking by a shrub or hedge, will quite thoughtlessly pick a leaf that brushes against the hand, not stopping to consider that in a public park or garden, where one hundred to several hundred or even a thousand people pass daily, the shrub would be defoliated if all were equally thoughtless.

While the above view is the charitable one to take, there are times when the facts are such as to make it almost impossible to hold such a view. If, for example, one takes the trouble to bring from some distance a large stone and to throw it with sufficient

force to break a large sign or label; or if, as once actually happened in the Brooklyn Botanic Garden, one brings a revolver into the grounds and deliberately fires at the labels; if one takes a dog into an inclosure and allows him to run at random over flower beds, when a sign at the entrance states in legible letters that dogs are not allowed to enter; or if one pulls up a large number of labels and piles them in a heap, thus introducing serious confusion in a planting, and entailing considerable labor, with attendant expense, to right the wrong, and especially when the offense is repeated several times in one season; or, again, if one deliberately picks all the flowers from a rare gentian or from a small patch of trailing arbutus, in such cases one is forced to conclude that the nuisance was committed either in a malicious spirit, or at least with a full realization of its significance and wrongfulness.

If the girdling of our white birch were interpreted in the charitable way, the affair seemed to offer an opportunity to teach an important lesson in plant physiology, and an equally important lesson in social ethics. It was therefore decided to prepare a label calling attention to the injury of the tree, and briefly stating the botanical reasons why the tree would die as a result of the girdling. The label read as follows:

NOTICE
THIS TREE

For an unknown reason some visitors to the Botanic Garden have removed the bark all the way around, near the base of this tree-trunk.

Doubtless the serious nature of the injury was not known by those who did it, but **nothing can now save the life of the tree.** Its leaves will remain fresh for the rest of the summer, because the water necessary to keep them fresh *passes up through the wood* just inside the bark.

The leaves make the food that nourishes the roots and other parts, and this food *passes down through the bark.* Thus, after the removal of the bark, no food can reach the roots and the base of the trunk, and hence these parts will starve. The tree will therefore not put forth any leaves next spring, and will have to be cut down.

If these facts had been known, the injury might not have been done.

BROOKLYN BOTANIC GARDEN

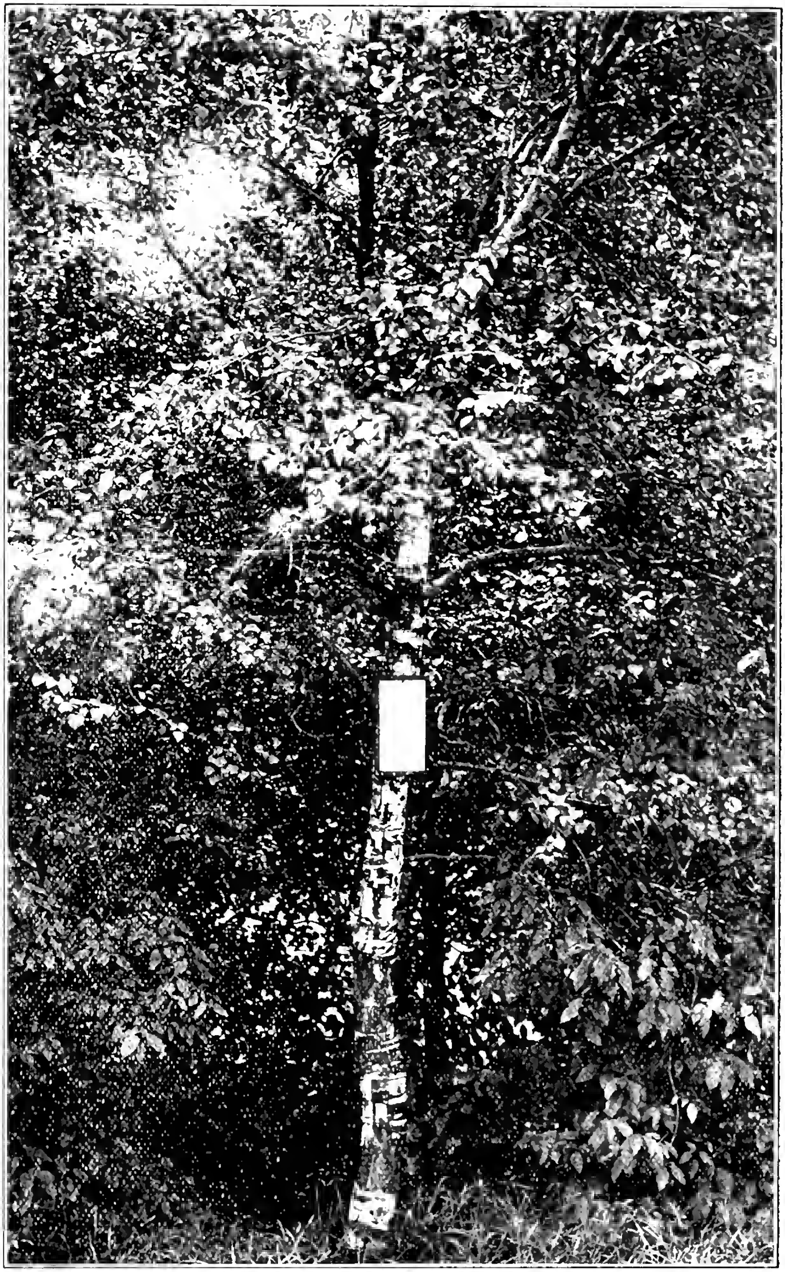

Fig. 6. White birch (*Betula populifolia*), girdled near the base of the trunk, and with blanket label affixed, explaining the serious nature of the injury. Photographed August 14, 1911.

Fig. 7. White birch (*BETULA POPULIFOLIA*), girdled. The same tree as that shown in Fig. 1, as it appeared May 14, 1912, without the foliage.

The label was neatly framed and affixed to the tree at about the level of the eye. This proved to be a matter of considerable public interest—more, in fact, than was anticipated. Most persons who passed the tree read the label, and several high school teachers included a study of it in their field lessons with classes in the Garden, the classes copying the label into their note books.

Figure 6 shows the tree in full foliage and with the label affixed, as it appeared on August 14, 1911, shortly after the bark was removed. As predicted, the tree failed to put forth leaves the following season, except a few scattered and poorly developed ones, though the catkins appeared in profuse numbers. This was not unexpected, for it is rather usual, when the vegetative functions of plants are interfered with, for the reproductive activity to become more vigorous.

Figure 7 shows the tree as it appeared the following spring (May 14, 1912), with abundant foliage appearing on adjacent trees. The tree has since been cut down.

It was somewhat discouraging to find that, in spite of the botanical and ethical teaching of the label above described, a similar offence was committed again, in the spring of 1913, on the opposite side of the Garden. This would tend to support the theory that vandalism is sometimes, at least, intentional and malicious. However, the second offence, like the first, was utilized to press home the needed lessons in plant life and personal conduct, and the label was affixed to the second tree. Here, as elsewhere, education must proceed in accordance with the old formula: "Line upon line, precept upon precept."

C. S. G.

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Em. Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., SEPTEMBER 9, 1914 NUMBER 8

HEREDITY, VARIATION AND ENVIRONMENT

"Flower in the crannied wall,
I pluck you out of the crannies,
I hold you here, root and all, in my hand,
Little flower—but *if* I could understand
What you are, root and all, and all in all,
I should know what God and man is."

Endless variety is the most noticeable thing about the world in which we live. So seldom do we find two living things the exact duplicates of each other, that when we do they are very likely to excite great wonderment. Our friends are short, tall or medium in height; blue, brown, gray or black eyed; red, brown, gray or black haired; flat, hooked, straight or bent nosed. The plants in our windows and yards possess no two leaves, nor flowers, nor branches exactly alike, and the differences between the individual plants themselves, when examined closely, even when belonging to the same variety, are as marked as those by which we distinguish our friends from each other. So great a place in the living world has this thing we call variability that, with all their very best efforts put forward, our breeders, agriculturists and seedsmen cannot keep it within legitimate bounds. Vegetable and flowering plants must be extremely carefully watched on the big seed farms to keep down the rogues, or worthless variations. Stock breeders must be ever on the alert to keep their breeding animals up to the standard breed type. Grain growers, potato farmers and florists suffer from the so-called running out of once valuable varieties. Disease-resistant wheat from Australia almost

entirely loses this quality when grown in North Dakota and subjected to the same disease. The tall trees of one climate may be the dwarfs of another. The obscure and little known insects and wild plants of one country may be the scourges of another, and the weeds of the tropics may become in part the hothouse plants of America and Europe.

On the other hand, certain individual organisms are so strikingly alike that we are able to group them roughly into varieties, species, genera, etc., realizing, however, that this represents but a convenient method of keeping track of them, for, no one who has really studied the subject thoroughly believes in the reality of species. And yet the individuals composing some varieties and species are remarkably alike, and especially is this true of many garden varieties of plants. We are told that a certain Dutch bulb-grower was able to distinguish 1200 varieties of tulips from each other by observations on the bulbs alone, and it is a common thing for nursery employees to be able to separate many varieties of plum and apple trees as they lie piled in the storage cellars, devoid of leaves. Practically all the navel oranges from the thousands of California groves represent fruit from the parts of a single tree discovered near Bahia, Brazil. How they differ in size, taste and flavor, and yet how similar to each other in color, in lack of seeds and in the presence of the navel! Naturalists find our little shepherd's purse and a variety of brake-fern all over the world, and they have no difficulty in recognizing them. Other plants, such as our wild asters and thorn apples, refuse to be specified, and no one, not even the greatest specialists on these groups, are certain that they can correctly identify them. When we attempt to define a species by placing all the individuals from a single ancestor or a pair of ancestors under the same name, we are again face to face with variation. In the natural world, like only produces like when we are speaking superficially. Blue-flowered chicory gives rise to white-flowered plants, as well as to forms differing in many less striking characters; spotted beetles produce plain-colored beetles; twenty-four leaved typical tobacco plants are parents of plants with 150 leaves; round-stemmed weeds have both round and flat-stemmed descendants. Examples such as these are a matter of common observation among students of experimental botany. It is only when one carefully isolates single plants or animals and puts them and their descendants through a purifying process that like begins to produce like, and this is what the breeder of new varieties of animals and plants attempts to do.

For centuries, scientific men have grappled with this problem of variation, attempting to find some law or order in all the seem-

ing chaos that it produces. When characters such as blue eyes were common to both parent and child, they called it an inherited character. But often brown-eyed parents had both blue and brown-eyed children. Then chaos reigned again. Theories innumerable were propounded to account for the manner in which characters arose, and were or were not inherited. The wildest superstitions were common. Strawberry-like birthmarks appeared on children because the mother had seen or dreamed of strawberries preceding its birth. Hours were spent before statues and beautiful paintings, so that the unborn child might be beautiful. Experiments by learned men were few and far between, and resulted only in more theory, or in collections of interesting but isolated facts. Heredity, says an old writer, is a curious collection of uncorrelated facts with no laws.

Then came Gregor Mendel, the Austrian monk, with his precise mathematical mind; and, with studied care, he thought out some experiments that might prove helpful in bringing order out chaos. He carefully selected his material, made sure by actual tests that it bred true to certain well defined characters, and then proceeded with some crossing experiments between varieties which differed from each other in one or more of these tested, true-breeding characters. When a tall pea was crossed with a dwarf pea plant, the progeny were all tall, and when the seed of these talls were planted, tall plants and dwarf plants appeared in the proportion of three talls to one dwarf. All the dwarfs and approximately one-third of the tall plants bred true respectively to dwarfness and tallness, but the remaining tall plants produced seed which gave again the ratio of three tall plants to one dwarf. From extensive experiments tried since, we have every reason to believe that two-thirds of the talls from such a cross after the first generation would always produce dwarfs and talls in approximately the three to one ratio. Other characters, such as green and yellow seed, green and yellow foliage, round and flat stems, were tested by Mendel in this manner, and the results they gave agreed with those obtained in the first example. Next he crossed varieties which bred true to two of these characters. When tall, yellow-seeded peas were crossed with dwarf, green-seeded peas, the offspring were all uniformly tall and yellow-seeded. When seed of these were sown, four kinds of pea plants appeared, and in approximately the following ratio: nine tall yellow-seeded, three tall green-seeded, three dwarf yellow-seeded, and one dwarf green-seeded. Without bothering with further details, it is only necessary to say that from these and other results he formulated the first clear law of heredity that is extant—the so-called *law of segregation*. He found that different characters appeared to act as units in heredity, and that these could be transferred from one

variety of plant to another variety independently of all its other characters. It was but a natural step, then, to consider that all organisms were made up of many independent character materials, each of which could be separately inherited. Mendel published an account of his work in 1866 in the transactions of the local scientific society of Brünn, Austria, where he lived, and for nearly forty years it remained unnoticed.

Then three European botanists, experimenting along similar lines, each independently rediscovered the law, and Mendel's long-forgotten account was resurrected and brought out into the limelight. A new science grew up, and interest in plant and and animal breeding spread with whirlwind rapidity. Through Mendel's work, and the encouragement derived therefrom, we are beginning to understand the nature of variation and heredity and their relation to environment. We are able to classify the kinds of variation from the standpoint of cause. When two varieties of corn, breeding true to ears with all white grains, are crossed, and the progeny are found to consist of some plants with ears of all red grains, others with ears of all blue grains, others with ears of all white grains, and still other plants with ears of red and white grains mixed, red and blue grains, blue and white grains, and blue, red and white grains, we are not forced back to the old-time chaos. Thanks to Mendel's conception, we are able to see law and order in this seemingly chaotic result, and, more important still, we are able to secure the same result again and again. Many modifications of Mendel's original conception have taken place, as one might naturally expect, when thousands of experimenters are working upon hundreds of different plant and animal variations. Important among these modifications is our conception of what constitutes a character. We have been forced to drop the vague meaning attached to this term by the older biologists and adopt the usage of the chemists and physicists. In this sense, a character must always be looked upon as the result of heredity and environment. The heredity units themselves are not characters, but, in conjunction with environment, express themselves as characters. They themselves must be looked upon as the primary elements of the living world, just as oxygen and hydrogen represent elements of the so-called inorganic world. But such modifications, important as they are, are but superstructures built on the foundation stones and methods laid down by Mendel.

With the aid of Mendel's conception, experimenters soon came to a new conclusion regarding the rôle selection played in the creation of new varieties. They found that certain varieties of wheat, beans, etc., when once freed from impurities by constant

Fig. 1. Modification of the dandelion by environment. Divided portions of the same plant, the tall plant being valley grown, while the dwarf portion is mountain grown (after Bonnier).

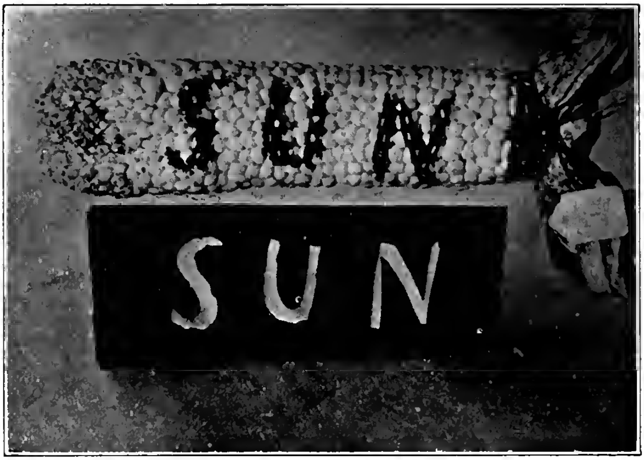

Fig. 2. Modification of skin color in corn by environment (after Emerson).

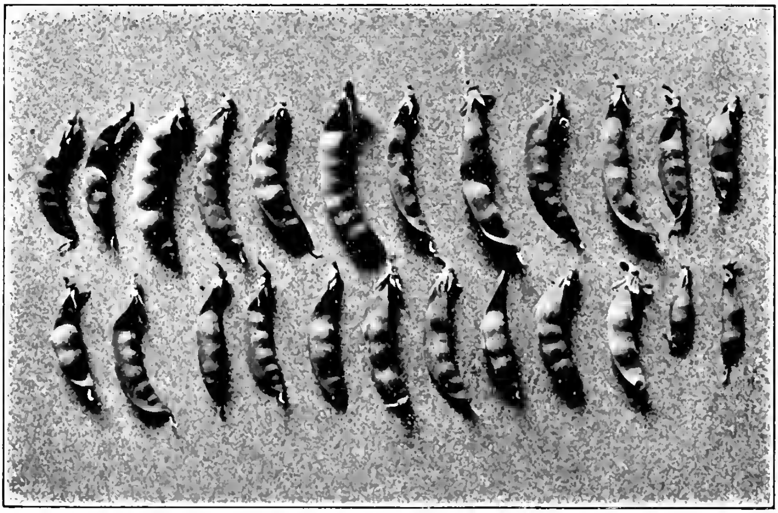

Fig. 3. Pea pods from a single plant. Differences in length of pods are due to environment.

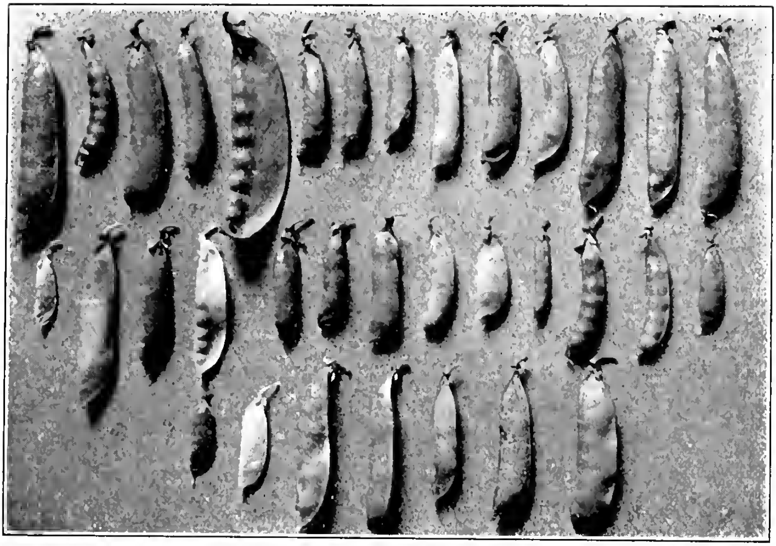

Fig. 4. Typical pods from thirty-four commercial varieties of peas. Differences in length due to heredity.

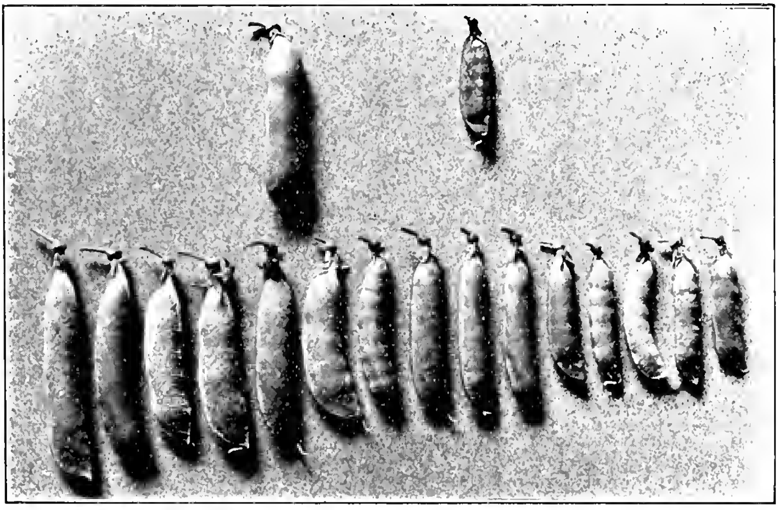

Fig. 5. Pea pods from two grandparents and fifteen of their grandchildren.

inbreeding, practically bred true, provided they were always subjected to the same environmental conditions. Certain varieties of wheat thus treated have remained the same for forty years, and the Vilmorin seed firm of Paris has a series of excellently preserved herbarium specimens whereby this statement may be proved. On the basis of this and similar evidence, selection is not a creative agent. Selection, so many of us believe, cannot change the nature of the hereditary units. One may never hope to secure blue roses from red roses by selection. One must patiently wait for the variation to arise, caused by no one knows as yet what, and then isolate it. Very often variations that arise in this manner breed true at once.

Inasmuch as most of the higher plants and animals result from a union of two microscopic cells, and as each of these cells may carry the hereditary units which together with environment, are responsible for the characters of these organisms, it follows that every sexually produced animal or plant that breeds true for several successive generations must have at least two of these units, identical in every respect, for *each* of the *characters* in which it breeds true. The only exceptions are those cases where a number of characters result from one kind of unit, in which case two identical hereditary units may be sufficient for several characters.

Granting then, that the Mendelian method of analysis is applicable to practically all the characters of the world of living organisms,—that animals and plants are made up of independently inherited units which, in contact with environment, express themselves as characters, and granting that these units are unvariable and not modifiable by selection, how can we account for all the variability we see about us?

If our modern conceptions of the composition of organisms hold, variation may only occur:

1. When the complex of hereditary units constituting the organism remain the same, and the external environment (e.g., soil, climate, food.) is changed.

2. When one or more of these units is added or subtracted from the organism (through crossing), the external environment remaining unchanged.

3. When both the complex of hereditary units and the environment are altered.

4. When both the complex of hereditary units and the environment remain the same, but a new hereditary unit is added or subtracted (mutation). The method by which this is accomplished is unknown.

All four of these statements are illustrated by the experiments in progress in the plant-breeding section of the Brooklyn Botanic Garden. However, all except the last one of them

may be proved to one's own satisfaction by experiments in a kitchen garden, providing one is careful to select plant material that is easily controlled, not easily affected by slight changes of environment, and normally self-fertilizes (inbreeds) itself, yet is easy to cross. Varieties of peas are excellent material.

The first of these statements can be demonstrated by making several cuttings of a pink-flowered hydrangea. All the cuttings from the same plant generally have the same hereditary units. If some of these cuttings are grown in ordinary soil and some are grown in soil strongly impregnated with alum water, both pink-flowered and blue-flowered plants will result, and the blue flowers will be the result of a change in environment. Figures 1 and 2 represent the same conditions. The two parts of the same dandelion plant were subjected to different environments. Pea seeds, from a variety breeding true to tallness, will demonstrate the same fact, as the seeds, if planted in poor soil, will produce dwarf plants. Figure 2 illustrates how red grains of corn may be produced through the action of sunlight. Ordinarily the mature grains of this variety are almost white, because the light is kept away from them by the husk. Figure 3 shows the variability of length of pods in a single pea plant. Environment is responsible for these differences in length. Figure 4 is a photograph showing the typical character of the pods in thirty or more varieties of garden peas, planted at the same time and growing under practically the same conditions of soil, climate, etc. The differences between these varieties as regards pod characters are due to different hereditary units. This is one of the many illustrations one might give of statement 2, as most garden varieties of peas have probably arisen thru crossing. Figure 5 shows the results of crossing a pea with small pods with a variety having medium sized pods. The long row of pods is made up of a typical specimen from each of 15 second generation progeny, the first crossed generation not being represented. These two varieties evidently differed in many hereditary units for pod length.

Statement 3 can be demonstrated by crossing tall and dwarf peas, and subjecting the second generation from such a cross to drought and poor soil conditions. If these are vigorously enough applied, all the peas will remain dwarfs; whereas three-fourths of them should be tall.

Statement 4 is well demonstrated by two varieties of tobacco growing in the plant-breeding plots of the Brooklyn Botanic Garden. The individual plants of one of these varieties are similar to the parent plant from which the other variety originated. This parent type had from 18 to 24 leaves, a round stem and normal 5-petaled flowers. The other variety, which originated from

such a plant as described above, has from 40 to 180 leaves, a flat stem and from 6- to 20-petaled flowers. This new type or mutation, as it would be called, bred true to these characteristics from the first. This new mutant type, in addition, excellently illustrates a case of how one sort of hereditary unit may express itself as a number of distinct characters, for the number of leaves per plant, the character of the stem, and the number of petals per flower, are looked upon by those who classify plants as separate characters. They are inherited however as though they were all tied together.

In order to demonstrate the statements cited above, the character of the material cannot be too strongly emphasized. Many misunderstandings have arisen, even among investigators, owing to their use of very complex material, material that would necessitate attacking these problems on their most difficult front. Human beings, for example, present such difficult material, and one tackling the problems of heredity, variation and environment solely by means of this material reminds us of those people who are determined to do things in the most difficult manner possible. One of the elements of Mendel's claim to greatness is the foresight with which he reduced his problems to their simplest form. The steam engines of today are comparatively simple to those trained to build and operate them, but to the inventor of the first steam engine, their complexity would be appalling and incomprehensible.

O. E. W.

NOTICES

The Garden is open to the public daily, from 8 a. m. until sunset; on Sundays and holidays at 10 a. m. Conservatories open April 1–Oct. 1, 10 a. m.–4:30 p. m.; Oct. 1–April 1, 10 a. m.–4 p. m.

During the present season and until further notice, entrance to the Garden may be had only at the laboratory building on Washington Avenue, opposite Montgomery Street, on permission from the office. This temporary regulation is made necessary by extensive grading operations and the construction of new paths throughout the grounds.

The Garden may be reached by Flatbush Avenue trolley to Malbone Street; Franklin Avenue and Lorimer Street trolleys to Washington Avenue; St. John's Place trolley to Sterling Place; Ninth Avenue, Sixteenth Avenue, Union Street, Greenpoint and Smith Street trolleys to Prospect Park Plaza and Union Street, and Brighton Beach elevated to Consumers' Park Station. (The elevated train stops only when the conductor is notified in advance.)

A docent will meet parties by appointment and conduct them through the Garden.

Current numbers of Leaflets are free to all who wish them. Back series, complete, 50 cents each; single numbers, 5 cents each.

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Geo. Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., SEPTEMBER 16, 1914 NUMBER 9

HEDGE PLANTS

A healthy, well-grown hedge when formed of the right material and occupying the proper position in the garden is extremely attractive and beautiful. Hedges, of course, are sometimes planted for other reasons than that of ornament. Their primary object may be to act as windbreaks, screens to ensure privacy, to mark boundary lines, or for defensive purposes. It is with the object of calling attention to some of the more desirable plants, and indicating briefly the methods to follow in order to obtain a good ornamental hedge, that this leaflet is written.

There are many points to be considered when selecting subjects for use as hedges. The plants must be hardy, not subject to insect or fungous pests, they must be naturally of symmetrical form or of such a character that they may be brought into the desired shape by pruning or shearing; and, further, they must be plants that are easily propagated or the price will be prohibitive.

If the soil is naturally good very little preparation is needed before planting, beyond digging in, or plowing in, a dressing of manure, but if the soil is poor it is advisable to make a trench two feet wide and deep and fill it in with good soil. If this cannot be done the next best thing is to break up the ground to the depth mentioned and incorporate a liberal quantity of well decayed manure. If possible the ground should be prepared some months before planting so that it has time to settle. If this is impracticable the soil should be firmed by treading.

When planting, a line should be stretched along the space to be planted to ensure perfect alignment of the hedge. A start

should be made at one end, taking out sufficient soil with a spade to make a hole which will accommodate the roots of the plant without crowding. The soil for filling around the roots of the first plant can be taken from the space to be occupied by the second plant, and so on to the end of the line. It is essential that the soil around the roots be thoroughly firmed by ramming, or by treading.

The depth to plant is dependent upon the character of the plants used. Privet may be planted three inches deeper than the plants were when in the nursery, but in the majority of cases, especially in the case of evergreens, they should not be placed deeper than the soil line which marks the depth to which they were planted in the nursery.

No hard and fast rule can be laid down as to the distance to be allowed between the plants. Privet is generally planted one foot apart, the Japanese Barberry nine inches to one foot, and evergreens one foot to four feet, according to size.

The time of planting is dependent upon whether evergreen or deciduous plants are to be used. Evergreens may be planted in August or September, also in May and June. Planting of deciduous kinds may commence at the end of September and continue until the ground becomes frozen. Spring planting may commence as soon as the soil is in a workable condition and continue until growth commences.

Immediately after planting, most deciduous kinds should be pruned back severely in order to promote the formation of a bushy hedge with foliage down to the ground. It is a mistake to allow a hedge to increase in height too rapidly, as this tends to prevent it acquiring the solidity and bushiness that is desirable.

The amount of shearing required depends largely upon the taste of the individual. Many of the plants mentioned in the following list need little or no shearing, while, on the other hand, privet may have a weekly clipping if a very trim hedge is desired. It is usual, however, to shear privet about three times during the year.

It is feasible to clip hedges into various geometrical shapes, but it is desirable to decide upon a form that is somewhat pyramidal, as this lessens danger of breakage by reason of snow in winter.

Of all the plants that are used for hedges in this country the most common is the California Privet (*Ligustrum ovalifolium*). This result has been achieved by its cheapness, hardiness, freedom from insect and fungous pests, and its amenability to constant shearing makes it valuable when a formal shaped hedge is

desired. There are several other varieties of privet that can be used to advantage. Among these are Ibota Privet (*Ligustrum Ibota*); Regel's Privet (*L. Ibota Regelianum*); and the Amur River Privet (*L. amurense*).

Aralia pentaphylla is a Japanese shrub of rapid growth. It has light green, palmate leaves which are very glossy, produced on gracefully arching stems. It has the advantage of growing well in poor soil and in shade. It is best if left to grow more or less naturally, merely pruning it sufficiently to keep the hedge in shape and from growing too large.

The Japanese Barberry (*Berberis Thunbergii*) is a charming plant when a low hedge is required. It is extremely hardy and does not need shearing to the extent that the privet does as it is naturally a compact plant. In fall the foliage colors beautifully, the bright red fruits persist all winter and the hedge presents a remarkably fine effect especially in spring when the buds are seen in conjunction with the fruits.

The Common Barberry (*Berberis vulgaris*) or better still the purple leaved form (*B. vulgaris purpurea*) is very suitable if a taller hedge is desired. It has not so dense a growth as the Japanese Barberry.

The Scarlet Japanese Quince (*Cydonia japonica*) is worth considering by those who desire a hedge somewhat out of the common. It is not an ideal hedge plant, on account of its somewhat ungainly growth, but, with careful pruning, it can be made into a beautiful border. Its scarlet flowers are produced in spring before the leaves appear, and are very pleasing.

Deutzia gracilis and *D. hybrida Lemoinei* are valuable hedge plants which should not be sheared. They are both dwarf, but *D. Lemoinei* has larger flowers and is somewhat more vigorous than *D. gracilis*.

The Garland Syringa (*Philadelphus coronarius*) is valuable when a tall-growing, informal hedge is desired. This plant is well known and greatly admired for its sweet-scented white flowers, which are produced in great profusion. A smaller-growing plant of the same genus is *P. microphyllus*, which is useful for forming a dwarf hedge.

Many of the Roses are well adapted for the purpose of forming hedges. Probably the best is *Rosa rugosa*, the Japanese Rose. This plant possesses many admirable qualities. It is extremely hardy; it will grow in almost any situation and is not particular as to soil requirements. It has handsome, shining foliage, beautiful flowers, and large, red fruits, which persist until late fall and early winter.

A beautiful, rather tall-growing hedge can be made by using various species and varieties of Lilac (*Syringa*). These plants are too well known to need any description.

Van Houtt's Spiraea (*Spiraea Van Houtti*) is the most beautiful of the early-blooming Spiraeas, and is highly recommended for an ornamental spring flowering hedge.

The plants mentioned above are all more or less deciduous, and when one comes to consider the evergreen plants that are suitable for hedges, one has a somewhat more restricted field to choose from.

The most ornamental evergreen hedge, when healthy and well grown, is the Hemlock (*Tsuga canadensis*). Unfortunately this is a rather capricious plant, and, although a native, it is sometimes difficult to get plants to grow satisfactorily.

Probably the most successful evergreen hedge for this part of the country is the American Arborvitae (*Thuya occidentalis*). This plant and its varieties are excellent and stand shearing without resentment. If a low-growing hedge is required, *T. occidentalis globosa* may be planted.

The White Spruce (*Picea alba*) is a good plant to use, especially if a large-growing hedge is needed. It requires careful pruning in order to have the hedge clothed to the bottom with foliage.

The names of many other plants might be given which are suitable for the subject under discussion. It is hoped, however, that enough has been said to show that one need not be restricted, when planning for a hedge, to California Privet.

M. F.

Wm Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II   BROOKLYN, N. Y., SEPTEMBER 30, 1914   NUMBER 10

WINDOW BOXES

The window box offers an opportunity for winter gardening to many people who otherwise could do nothing at all in plant culture for lack of space. But, unfortunately, the plants in such a box often do not thrive. This is due usually to a lack of understanding on the part of the individual. Either he has failed to take into consideration the light conditions under which he is forcing his plants to live or he has neglected to provide properly for drainage. Indeed, the most important factors in this problem are light and drainage.

The window box itself is usually a plain wooden one. White pine is considered the best wood in use, as the wood must be light and able to withstand a considerable amount of moisture. Certain woods could not be used at all; but white pine seems to answer these requirements better than most others. The outside of the box is painted or stained; this is done for general effect and also because the paint helps to close up the pores on the outer surface of the wood. Green, nature's own scheme for color settings, is perhaps the most satisfactory one for the box.

Dimensions for construction are as follows: *length*, determined by the length of window sill on which the box is to be placed: *width*, about 8 inches; *depth*, 7 or 8 inches inside measure; *thickness of wood*, $\frac{7}{8}$ inch. In each square foot of bottom surface bore four drainage holes, $\frac{1}{2}$ inch in diameter. Do not fit the end pieces between the side pieces, but use the opposite construction. If the former is used, the box is likely to spring apart and warp. Dovetail the joints, if possible, or try half-wood jointing.

Some window boxes are more elaborate in their construction than these ordinary ones. Such boxes often have zinc inner boxes, in which the plants are placed. There is a zinc drip-pan beneath the zinc box, so water never touches the outer wooden box.

Drainage must be right, if one is to have a reasonable amount of success in window gardening. So, after placing curved pieces of crock over the drainage holes, put about two inches of drainage material into the box. This material may be broken crock, charcoal, rotted sod, or even stone. (See LEAFLETS Number 12, Series I, Figure 5, for potting process. It is not necessary to use the bed of sand.)

The soil in a window box often becomes clogged with water, sour and soggy. The loose drainage area is used to prevent this condition. Surplus water, standing at the bottom of the box, does little harm if the drainage area is right. Roots of plants must have plenty of air and be in a sweet condition, which is impossible if they are surrounded by soggy soil. Some people put charcoal in with other drainage material, trusting that it will act as an agent of absorption for unpleasant odors and gases.

The soil for the window box should be especially rich and light. If one has ordinarily good loam, it may be used as it is. There are many receipts for mixing of soils. One mixture is the following: one-third garden soil or fibrous loam, one-third well-rotted manure, and one-third sand, sifted through a quarter-inch screen. Another mixture is this one: leaf mould, garden soil or loam, and sand, mixed in equal parts. The sand should be sharp sand, such as that used by masons. Sand assists in the process of drainage. Leaf mould makes the resultant soil more friable, allows air to circulate more freely through the soil, and helps root growth. Rotted manure also lightens soil and adds valuable elements of plant food to the mixture. If soil is heavy and cloggy, it must be lightened. For this purpose, use sand or well-rotted manure. A soil with an overplus of clay in it will become, at times, water-logged, heavy and cold.

As the soil is filled into the box above the drainage section, the level at which the plants are finally to stand must be determined. So take the plants which are to go into this box out of their individual pots. Be sure to get the ball of soil carefully out with each plant. To do this, take up the pot in the right hand, place the stalk of the plant between the middle and index finger of the left hand, invert the pot and strike its rim sharply against the edge of a table or any other solid surface. The plant, together with its ball of earth, should slip easily out of the pot. If the soil is dry, the ball will break apart, so be sure the soil is moist be-

fore unpotting. Place the plants, balls and all, upon the soil layer already in the box. Firm every plant into its place, thus making close contact between the balls of soil and the new potting soil. Roots and soil must be in union in order to insure growth.

Another important point to determine is that of the number of plants to the potting space. Window boxes undoubtedly look much better when the plants are crowded. So place them as near together as possible without having direct interference of their branches. When potting plants with their balls of soil, these latter help regulate the distance.

The selection of plants for the window box depends largely upon where it is to be placed. For if the box is to go in a window flooded with sunshine, the problem is an easy one. But if it is to have a northern exposure, one's choice in plants is limited. For any exposure the Geranium is the first choice. It is a very adaptable sort of plant, thriving in sun, yet accommodating itself to the less sunny spots. A box full of bright red or of pink Geraniums is a fine sight! It is the best plant of all for classrooms. Garden plants like the Heliotrope, Fuchsia, Coleus, Petunia and Marguerite do well in the box which has sunshine falling upon it throughout a part of the day. Use for vines, to trail over the edges, *Vinca major;* Wandering Jew, (*Tradescantia* sp.;) English Ivy, (*Hedera Helix;*) German Ivy, (*Senecio scandens;*) and Variegated Panicum, (*P. variegatum.*)

But the window box which must be placed in a window having little or no sunlight, presents a real problem. Plants must be chosen which can adapt themselves to shade or which naturally thrive in the shade. Try such plants as Fuchsias, Abutilons (Flowering Maple,) Begonias, Pandanus, Dracaenas, Aspidistras, Ferns and Palms. The Fibrous Begonias will give satisfaction in sunless windows, for they grow easily and remain in bloom for a long time. The Coral Begonia, *B. coccinea*, is perhaps the best one to choose. Other satisfactory varieties are *B. semperflorens*, *B. metallica* and *B. sanguinea*. Dracaenas and Aspidistras are used more often in separate pots. Boston Ferns and Palms, such as *Cocos Weddelliana* and *Kentia Belmoreana*, may be used in window boxes. But if they are used, it is far better to have the box made up entirely of either Ferns or Palms. For these plants need different treatment from that given to the ordinary house plant, such as the Geranium. Palms require quantities of water; while Ferns do not like heavy soils.

Some people like to start their window boxes from seed. This is a rather slow process. An attractive, but expensive, sort of window box is one in which the plants, pot and all, are placed,

and then surrounded by damp sphagnum moss. One may keep changing the pots and so have blossoming plants in the box all the time.

Iron brackets may be screwed up beneath the window sill and the box placed on these. If the brackets are swinging ones they can be folded under the window when not in use. So one does not have to keep putting them up and taking them down. The weight of the box holds these swinging brackets apart.

Of course the plants in a window box may have all sorts of diseases and troubles. But this is a subject in itself. In general, if people keep their plants clean and properly watered, the plants thrive. Both surfaces of the leaves should be sponged occasionally in clear warm water. The under surface especially is one of the very busy, important and vital parts of plant structure.

E. E. S.

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Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., OCTOBER 7, 1914 NUMBER 11

THE POTATO INDUSTRY OF NORTHERN MAINE AND ITS RELATION TO THAT OF LONG ISLAND

The potato industry of Long Island is becoming increasingly important, especially for the northeastern corner of the Island. From the point of view of food supply, it is clear that such agricultural interests as these are intimately bound up with the welfare of New York City. At first thought, however, it seems a far cry from the potato fields of northern Maine to those of Long Island and New Jersey. Yet, as will be made plain from the following account, the connection is in reality a close and vital one.

Northern Maine is widely known as a region where hunting and fishing are excellent; its woods, lakes, and streams, together with its cool climate, make it an ideal summer resort. The popular conception of Maine, with its "rock-bound coast" and densely forested interior, gives the impression that it is not an agricultural country. Aroostook County, in the extreme northern part of the State, although containing much natural forest and possessing a season too short for most crops, nevertheless is peculiarly adapted to one crop—the potato. For the past fifty years land has been gradually cleared and potatoes planted, until in 1913 the production in that one county alone was about twenty-five million bushels, twenty-two million bushels being shipped out, and about

three million bushels used within the county as table potatoes or converted into starch. For seed purposes especially, Aroostook potatoes are well and favorably known all through the eastern trucking sections, and are used for planting as far south as Florida and Texas.

The reasons for this prestige are not hard to find. The potato, naturally almost a shade plant, thrives in the cool climate of that country; the soil, a loose, well-drained loam, is particularly a potato soil; the rainfall is usually abundant. Being the main crop, thorough care is used in its production. And the superiority of northern grown, more immature, seed for planting further south has been repeatedly demonstrated. Aroostook County seed is especially valuable for this reason, and by railway and steamship is readily accessible to the trucking districts of the Atlantic States.

There can be no doubt but that the potato industry is not only of vital importance to northern Maine, where it has produced prosperity and wealth, but is likewise important to the whole eastern United States. This industry has been developing for some years, and in general has enjoyed a healthy growth. However, the very apparent simplicity of potato raising in northern Maine has resulted in some ill effects in the past; *e. g.*, the notion became prevalent that one could plant any sort of potatoes in Aroostook and harvest abundance. From sheer force of necessity, spraying to prevent late blight has been practiced for several years; but carelessness has been used in selection of the seed to be planted, as well as with regard to proper rotation of crops. Finally it resulted that diseases became very prevalent, not only in the tubers planted, but also in the soil itself, and varieties consequently began to "run out." It finally dawned upon some of the growers that, large though the yield was, it might be made larger, and the quality be made better.

The present is a time of awakening and endeavor to attain the maximum of quality and yield. A yield of three hundred bushels per acre has been common in the past; now and then a yield of five and six hundred bushels per acre was attained. This latter immense production of select, healthy potatoes is the goal toward which the wide-awake growers are now striving.

The primary cause resulting in this rejuvenation of the Aroostook potato industry was the discovery, in that county, of powdery scab, a serious, imported potato disease. This disease threatened to become disseminated throughout the whole country, so great is the distribution of northern Maine seed, some of which would, unless extreme care be exercised, undoubtedly be affected with this disease. Promptly upon its discovery, steps were taken by the State and Federal Departments of Agriculture to prevent shipment of tubers infected with powdery scab. The gospel of care and attention in the selection of the seed planted and shipped, preached first by plant pathologists, was taken up by wide-awake growers; adherence to this gospel was enforced by declaring a quarantine upon potatoes shipped, so that all had first to be inspected. While the eradication of this disease was being sought, other diseases were also brought to attention and avoided; varieties were cleaned up and freed from mixture with other varieties. The concensus of opinion now is that the discovery of this important disease in northern Maine was a blessing in disguise, and will result in much less potato disease there, as well as in better quality and better yield.

The Brooklyn Botanic Garden has been especially interested in this movement, particularly on account of the fact that one of the staff was temporarily released from Garden duties in order to take active part in the work. The writer, together with two other special students of potato diseases, accepted appointments for the season with some of the more progressive potato growers. The duties of these field workers were to keep close watch of all the details of selection, the proper methods of cutting, treating and planting of seed tubers; the control and final eradication of the diseases which appeared; the "roguing" for stray intruders in an otherwise pure variety; as well as the final harvesting, inspection and storage of the crop.

This year, practically for the first time, formaldehyde treatment of seed potatoes was practiced; many diseased plants have been removed from the fields, and the crop never looked cleaner and better. Thanks to the teaching of the plant pathologists and the enterprise of growers, northern Maine is still one of the most progressive and important potato raising sections of America.

The future of the potato industry in northern Maine may in general be prophesied as follows: the best seed the grower raises or can obtain will be planted on land that has been through the regular three year rotation of oats, clover, then potatoes. The fertilizer used will be the optimum of quantity in order to furnish sufficient plant food for the growth of a large crop. Diseases will be more intelligently watched for and avoided; and formaldehyde seed treatment, and spraying in the field will be thoroughly practiced. The various varieties will be freed from mixture and their type improved by selection and observation of growing plants. The yield will increase and the quality be better. Long Island, together with the whole Atlantic seaboard, will thus profit by the improved seed potatoes received from northern Maine.

G. R. B.

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Em Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., OCTOBER 21, 1914 NUMBER 12

THE HISTORY OF NICOTIANA II

AN ACCOUNT OF THE HEREDITY AND ENVIRONMENT OF A FAMILY OF TOBACCO PLANTS

Near the village of Alquiza, in the department of Partidos, Cuba, large plantations of tobacco are annually grown. The particular type of tobacco plant common to these plantations is about six feet tall, unbranched, round-stemmed and ordinarily clothed with from eighteen to twenty-four medium-sized, dark-green leaves. The flowers, though seldom seen, as they are cut off in the bud stage to prevent them from taking nourishment from the leaves, are pink in color and made up of four whorls, three of which consist of five parts, the fourth being two-parted. The whorls are botanically described as the calyx, the corolla, the androecium (stamens), and the gynoecium (pistil). The first two are protective and showy, while the last two are inconspicuous and concerned with reproduction. The androecium contains the male organs, while the gynoecium is devoted to producing plant eggs. Ordinarily in tobacco, the union (pollination and fertilization) of the two kinds of organs takes place in the bud, before it opens into a flower, so that the seed, which are really little plantlets in protective cases, have but one parent, both father and mother being represented by one plant. I mention this because most flowering plants are cross-fertilized, which in ordinary English means they have two separate plants as parents,—that the father (pollen parent) is a separate and distinct plant from the mother, or egg-parent. The fact that these tobacco plants are generally inbred, or self-fertilized, is important to my story, because it leads us to believe that perhaps through thousands of generations, made up of millions of plant individ-

uals, the hereditary materials which take part in character formation, have descended from plant to plant through a single, unbroken line of ancestors. Thus they are to be regarded as blue bloods of blue bloods because of their freedom from mixture. Such an unbroken ancestral line, from the standpoint of heredity, should breed as true to type from seed as though it had been propagated by cuttings; or, to draw an illustration from the world of inert matter, the individual plants in each generation and from generation to generation should be as like each other, under the the same environment, and barring mutations, as small, equal-sized bits of pure rock salt broken off from a larger piece of the same mineral.

Naturally, then, from what has been said, one might expect this ancestral line of plants growing about Alquiza to continue indefinitely to show these characteristics, these five-parted flowers, this round stem, and this small number of leaves, unless the environment was changed or mixture with other families of tobacco with different characters occurred. But in 1907 a single plant of a singularly new type appeared, a plant with a broad, flat stem, clothed with 152 dark-green leaves and crowned with pink flowers having from six to twenty floral parts in the three outer whorls, and from two to twenty-two floral parts in the gynoecial whorl. Thus appeared the first great recorded change in the character of this tobacco family. So far as the men who tended the fields knew, only one such mentioned plant appeared, and this one plant was found growing under practically the same conditions as the thousands of normal neighbor plants. Believing it to be of commercial value, one of the officials of the plantation had the flowers covered with bags, to make certain there would be no mixing, and seed was saved from it. The next year (1908) ninety-nine plants from this seed were grown under shade at North Bloomfield, Connecticut, and, although there was a wide range of variation in the number of leaves per plant, in the number of parts per flower, and in the diameter of the stem, one could see in each of the ninety-nine the dominant traits of their single Cuban ancestor. In every way they resembled that singular 1907 plant rather than their so-called normal relatives. Thus a new and distinct variety having clear-cut characters arose. How it all happened no one has any conception, for it is one of those comparatively rare mutations, and no student of the genesis of organic life has as yet been able even to make a reasonable guess at the causes which bring about a mutation. From 1908 to 1914, five successive generations, aggregating 800 or more individuals of this strain were grown, and all expressed the same monstrous characters of the mutant ancestor, even though they had been grown at different times under a wide range of environmental

conditions, including changes in climate, in amount of rainfall and in soil and pot-culture conditions. In the latter case, the general plant dimensions were reduced by almost half, but the typical monstrous peculiarities were in evidence as much as ever.

And such monstrous characters as they were! Great flat stems, at times three inches or more across, curved at the crown into semblances of shepherd's crooks or ram's horns, or surmounted with great crowded clusters of pink flowers, flowers which had absolutely no regard for regularity, as shown by their great extremes in number of floral parts among even the flowers of the same plant. Some flowers had 22 petals, others six, and there were even those which were joined together, honeysuckle fashion, in twos and threes and served by one calyx and one stem. Then there was sterility in various degrees, and broken tissue. For, often in growing to make the curves that simulated ram's horns, the stems cracked, and great cell areas were deprived of life. Under the same conditions, often growing beside them, were cultures of from 10 to 125 normal plants similar to the ancestral forbears of this monstrous strain. From generation to generation, they retained their old characters, their regularity in number of leaves and floral parts, their round stems and their fertility. What a contrast were they to this other strain with its irregularly placed leaves, and its great variation in leaf number per plant. For, not uncommonly seeds from a single capsule of the monstrous strain produced plants with 33 leaves or with 133 leaves, and this was true even though all the plants were grown under approximately the same environment. This great irregularity in the new strain is strictly hereditary. Attempts to reduce its variability through selection have so far resulted in failure, for seed from plants with 33 leaves are just as likely to produce plants with large numbers of leaves (100 to 133) as plants with small numbers of leaves (33 or more). Thus we have two strains of tobacco, totally different in character, each breeding true, and both coming from a common ancestor, an ancestor which possibly had had hundreds of generations back of it in a line unbroken by mixtures from related strains of tobacco, or even from single tobacco plants outside the direct line. One was terribly diseased, barely able to take care of itself under certain conditions, some of which were so favorable to the development of the monstrous characters that but few flowers and very little seed was produced, thus making the strain a poor competitor with other plants in the struggle for existence. On the other hand, the other or normal strain was in every way a much more successful struggler.

When the monstrous strain was crossed with individuals similar to the parent strain, the offspring from such matings were in-

termediate, though more like the normal parent, and practically just as able to care for themselves. There were no shepherd's crook or ram's horn distortions in these plants and they were as like each other as beans in a pod, though easily distinguished from either parent. But when offspring resulting from their guarded seed were raised, only approximately one half resembled the parent, while approximately one-fourth looked like the grandmother and one-fourth like the grandfather. Whenever guarded seed (seed from bagged flowers) was sown from either of these two latter, they always produced plants that one could not distinguish from their respective parents. However, seed from those grandchildren characterized as intermediate, always produced the three kinds of plants just mentioned, in approximately the proportions 1:2:1. From seven of these intermediates, 465 offspring were grown, 115 of which were similar to the original abnormal Cuban ancestor, 228 were intermediates, and 122 were normal plants, in all respects similar to the ancestor of the 1907 mutant plant. From experiments extending over five generations, we have found that these normal and abnormal plants breed true from generation to generation just as though they had never come from a mixed parentage. On the other hand, the intermediates of each generation have always thrown offspring of the three kinds and in the proportions of 1:2:1. From all we know at present about the inheritance of characters in plants and animals, this production of the three kinds by the intermediates would go on indefinitely, and the two small classes would breed true indefinitely, barring mutations and changes due to environment. From the facts just presented regarding what transpires when two such true-breeding plant types are crossed, we feel justified in asserting that this mutant race differs from the race that gave it birth in a single hereditary unit (or character differences that are inherited as a single unit) which is capable of expressing itself as a large number of taxonomic characters. For as we have seen, the distinguishing features of this strain are inherited as though they were all tied together. No matter how often these experiments wese repeated *with these strains*, the same results were always secured. After seeing this demonstrated anew from time to time, one comes to feel that we can be almost as certain of the result, as when one multiplies, adds, or subtracts the *figures 2 and 4*. This mating of the monstrous strain with individuals of a normal strain similar to its own normal ancestors marks the second of the great events in the history of this family.

The third great event resulted from matings of members of the monstrous strain with normal plants outside the family,—morganatic marriages, so to speak. The plant "classificationists" will tell you that all tobacco plants are normal that have characters

(a) (b)

Fig. 1. (a) Typical plant of the normal strain which gave rise to the fasciated strain (after U. S. Department of Agriculture). (b) Typical plant of the fasciated strain. Note the broad, flat stem.

(a) (b)

Fig. 2. (a) Flowers typical of a single plant of the fasciated strain. (b) Character of the inflorescence of the fasciated strain.

Fig. 3. Some types of stems from planis of the second and third generations of the cross between the fasciated strain and the bushy normal strain.

(a) (b)

Fig. 4. Two sister plants of the second generation of the cross between the fasciated strain and the bushy normal strain. (a) Normal. (b) Abnormal.

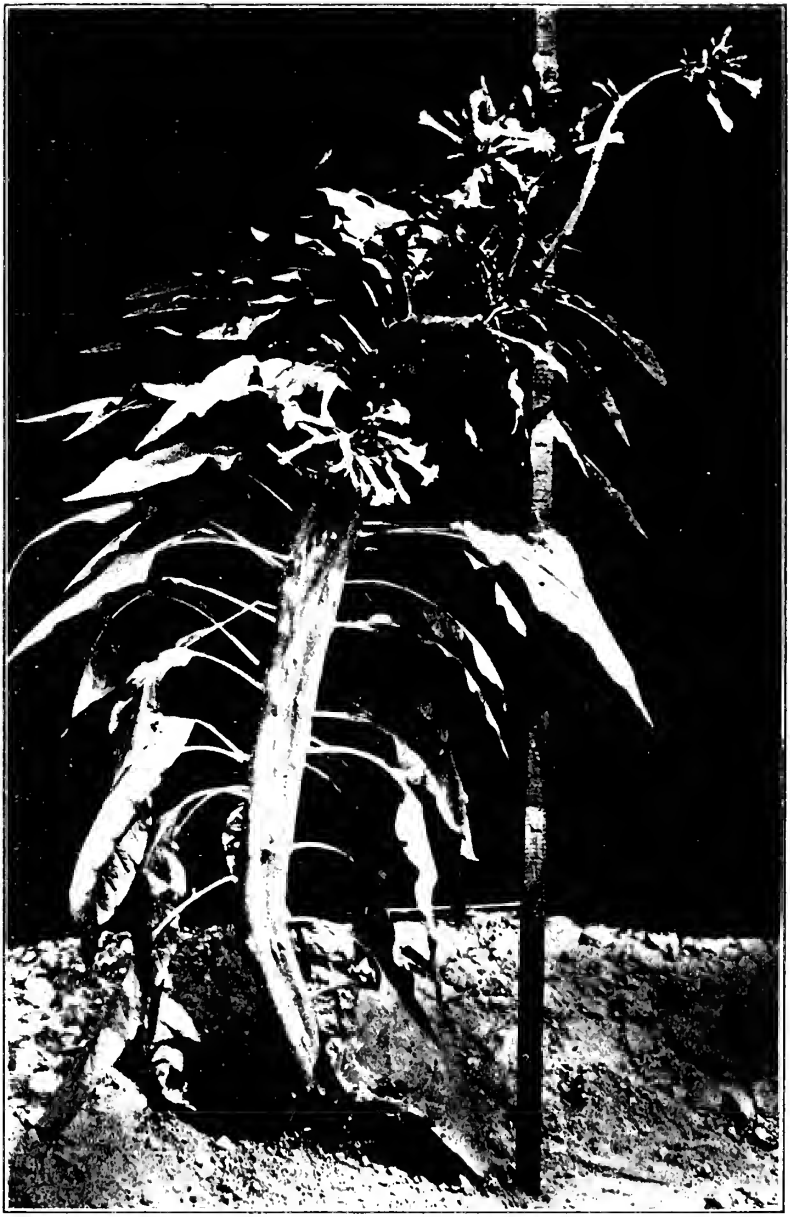

Fig. 5. A type of abnormal plant occurring in both the second and third generations of the cross between the fasciated strain and the bushy normal strain. The apex of the stem terminates in a coil.

which are like those they have written down in books as the *proper* characters for tobacco plants. And round stems, crowned with flowers with five petals, five stamens, and two ovary-locules are some of these *proper* characters. So the monstrous strain was mated to a little bushy branched variety which had these characters proper to normals, but which differed from the normal ancestor of the monstrous strain in leaf-shape, size, and number; in flower color, in height, in being branched and in many other characters. This mating at first resulted in no particular surprises, for the offspring were monotonous in their similarity and each resembled the little bushy parent except in being slightly taller and in displaying a few flowers on each plant with an extra floral part or two added to each whorl. But when guarded seed from any one of these was planted, the resulting offpring were as strikingly diverse as the population of Ellis Island or a New York school ground. Hundreds of progeny were grown but among them were to be found no duplicates. Classification on the basis of resemblance to parent, or to either grandparent was out of the question. Every plant, like the products of the Paris salôns, seemed to be a special creation. The gatherings at Babel could not have boasted of more striking diversities. There were plants short, medium and tall; plants with broad flat stems, narrow flat stems, square stems, round stems, and branched stems; plants with stems like a base-ball bat, and stems like a hockey stick, stems with a hundred or more irregularly placed leaves and stems comparatively bare of leaves. There were plants with flowers red and with flowers pink, with normal flowers, slightly abnormal flowers and very abnormal flowers. Plants with great massive flower heads, with their individual flowers packed together like people in a street mob, grew beside little plants with small, loose, floral crowns. Tall, broad-leaved, round-stemmed individuals grew beside and cut off the light from their short, thick-set, flat-stemmed sisters. And last and most curious of all were plants which were meant to be tall, but owing to their abnormal ancestry, they grew a foot or two and curled up their stems, after the maner of the capitals of an Ionic column (see *fig. 5*). Such a result from crossing the monstrous strain with a normal strain made one feel dubious regarding the operation of any law, especially when such a motley array were the offspring of a single plant. One's attempts to classify this progeny by disregarding all the other characters except those traceable to the monstrous grandparent were practically futile, because the *characters* of this monstrous ancestor were apparently inherited separately and not as though they were all tied together, as in the cross between the monstrous strain and its normal ancestor. There appeared to be every gradation of the abnormal character expressed, some plants resembling the monstrous grandparent, others mon-

strous enough as to flowers, but absolutely without any flatness of stem, others slightly abnormal in both flowers and stem. Even the separation of those truly normal from the abnormals was difficult because true normals sometimes have flowers with an extra petal or two, due to environmental causes.

When seeds from slightly abnormal plants were grown, sometimes they bred true, giving rise to a modified race of abnormals; in other cases, seed of this type produced monstrous abnormal plants like the great grandparent and normal plants in the ratio of three of the former to one of the latter; while in still other cases, only normal plants resulted. Strictly normal plants always produced normal progeny so far as they have been tested, but there are grounds for believing that further tests will show certain normals will produce abnormals. The modified abnormals mentioned above were only abnormal in their flowers, their stems being round and the number and arrangement of their leaves were also like normals. Monstrous plants resembling the 1907 ancestor in some cases produced only offspring like themselves, but in other cases their offspring consisted of various types of abnormal plants. *Figure 4* is a photograph of two offspring from a plant of the first generation of the normal × monster cross we have been talking about. Now what had happened to cause all this "messing up" of beautifully spun theories? Did the hereditary unit which differentiated the monster strain from the normal break up into numerous other units, or was it inherited intact and its ability to make itself known altered by the effect of other hereditary character-producing units, not encountered in the other normal strain. To me, the latter view seems the more reasonable, at least the more helpful, in trying to solve the problems of inheritance. So, upon this view, the difference in the results from crossing the monstrous strain with the two kinds of normals is explained by the difference in the kinds of hereditary units that made up the two normal races. In one case, the evidence leads us to believe that the monstrous and normal strain differ by a single hereditary unit, while in the case of the bushy normal, many hereditary differences were present, and some of these, such as that for branching, in expressing themselves, modified the appearance of some of the plants that hereditarily should have resembled their monstrous grandparent. Of the other unit-differences present in the bushy normal which helped to modify the appearance of the abnormal characters, we know nothing as yet, for the unravelling of the heredity skein of even such simple organisms as tobacco plants means far more than the patient efforts of one man's life time. For in order to study and isolate even one of these units, one must find a plant from which this particular unit is absent, and which in crosses with plants pos-

sessing this unit, will give fertile offspring. The study of the heredity of this family of tobacco plants has already covered six years, and involves records of over 7000 pedigreed plants. At present, some forty strains of tobacco, all related to the original monster plant found in Cuba, are growing in the Brooklyn Botanic Garden, and some of the individuals of these strains have far outdone that ancestor in monstrousness.

Now, what can one learn from the history of a family of mere tobacco plants? What valuable truths are to be deduced from such studies? Dare we apply the knowledge derived from a study of heredity and environment in tobacco plants to other plants and animals, particularly to man? As to the first two questions, one may say that such material as peas, beans, wheat, and commercial tobacco are about the best material one can find for unraveling the problems of heredity, because these plants ordinarily are self-fertilized, and hence freer from character mixtures than cross-fertilized plants and bisexually produced animals. All sexually produced organisms are believed to possess in each of their body cells two hereditary units, identical in every way, for each character or set of characters in which they breed true. At present, we know very little experimentally about the heredity of the majority of the character-producing materials of an organism. We know even less about the effect of the presence of the various kinds of character-forming material upon each other. We have very little conception of how many kinds of independent heredity units there are in even the simplest plants and animals. We do know, however, that some of these character materials cover up or obscure the presence of others. In attempting to secure a conception, then, of how an organism is put together, as to which characters are due to the presence of certain units, and which are due to the presence of other units, when all the units are under the same external environment, we must secure the best material possible—material most free from "impurities" or mixtures, material most likely to be pure, or homozygous, for each character. Otherwise, confusion indescribable results, and we get nowhere, save in accumulating interesting and inexplicable facts. So in using such simple material as tobacco or peas for our studies on heredity, we succeed in obtaining clues as to how the problems of inheritance and environment are to be solved. And what we find to be true in simple material, of course, helps us immensely in interpreting experimental data from complex material, such as man. The solving of difficult problems is, in some respects, similar to constructing a fine, durable building, for in both, suitable material to work with is a very essential feature. Any kind of material will not do. Mendel foresaw that fact when he began his studies on heredity, and it was for that reason mainly that he

succeeded in discovering clues and laws where others had failed.

And because of the discovery of these laws and clues, heredity is coming to have a new meaning to us. The folly of stratifying society into layers on the basis of ancestry, under the scrutiny of impartial scientific investigation, is becoming more apparent every day. We are beginning to realize that ancestral character heritages from royalty, or from those who came over in the Mayflower, or even from forbears of undoubted talent do not necessarily always make for the fit or the best. We are beginning to realize that the slums are not necessarily the abode of the unfit. For fit and unfit as society looks at it have more often resulted from the handing down of social prestige than from the inheritance of valuable qualities. Characters, as we are beginning to see, are results of both heredity and environment. The fit man of the pioneer knickerbocker days might make a sorry misfit in present New York life. And surely a great poet in a society that abhors poetry would be anything but a success. The same is true of plants: some varieties of apples do best in some localities and perhaps become only mediocre or even poor varieties in other localities, yet there has been no perceptible change in their hereditary make up. It is environment that has made the difference. Like, in nature, or in man, if we think of the individual as a whole, only rarely produces like, for most animals and plants are hybrids. From the standpoint of the modern investigations into the genealogy of plants and animals, our lives are largely mapped out or predetermined for us, but our fatalism differs from that of the past in that it is based on investigation and not resignation and superstition. Just as some of the tobacco plants when rooted to a certain environment, could not avoid being diseased, or in producing diseased as well as normal offspring, so it is with man. And so while we are learning how to make two blades of grass grow where only one grew before, we are also learning that once the variety which does this is produced, it cannot alter itself, provided its environment remains the same and no mutation occurs.

Can the knowledge derived from a study of tobacco plants and pea plants be applied to the solving of the problems of heredity in animals, particularly man? The best answer is that they have already been making these applications—Davenport, Jordan, Goddard and a host of others. But the first clue to the solution of these problems, we must remember, came to us from a monk's garden in distant Moravia and from clear sighted studies on the comparatively simple garden pea.

O. E. W.

E. W. Kittredge.

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES II BROOKLYN, N. Y., OCTOBER 28, 1914 NOS. 13 AND 14

GRAFTS, GRAFTING AND GRAFT-HYBRIDS

"By the faith of men,
We have some old crab-trees here at home that will not
Be grafted to your relish."—SHAKESPEAR.

Grafting, as everyone knows, is a word of many meanings and many associations. As applied to plants, the process of grafting increases the value of certain kinds of fruit and ornamental plants from that of a few dollars to many thousands of dollars. For example, the thousands of dollars' worth of Baldwin apples that are brought to our markets each year are the output from orchards made possible through grafting. For, prior to 1793, the Baldwin apple existed in Massachusetts as a single tree, whose fruit was probably known only to the youngsters of a very restricted countryside. To-day, thousands of trees of this variety are growing all over the northern United States, and every little hamlet grocery receives its quota of Baldwin apples. Far more interesting, however, than the fact of nation-wide appreciation of the Baldwin is the method by which the fruiting area of this variety has been increased, for all the thousands of barrels are in reality the fruit of that original Massachusetts tree, and the so-called Baldwin trees of the thousand and one orchards scattered over the country are grafts or twigs from this original tree, so manipulated that they are growing on the roots of other varieties of apple—varieties so numerous and so unimportant, commercially speaking, that no name is ever given to them. In reality, then, every so-called Baldwin tree, except the original

one, consists of two parts, the above-ground fruiting part, which has all developed from a twig of the original tree, and the below-ground or root part, which is not Baldwin at all, but simply a nondescript seedling about which one is not particular, providing it has a strong, hardy root system, is more or less resistant to root diseases, is suited to the soil conditions, and fulfills its duty as the provider of the raw food material for the upper or important part of the tree. *Figure 1* represents a series of illustrations showing how this process of grafting is accomplished. Several methods are illustrated, but these are only a few of a very large number of ways in which this result is brought about. The upper part of the tree, the Baldwin part, is technically called a scion, while the lower or root part is called the stock. In nurseries, the stocks are grown from the apple seeds secured from the cider mills of New England, especially those of Vermont, or from imported French apple seed. In the colder northwest prairie states, where the temperature in winter goes down as low as 40° F. below zero, Russian and Siberian crab-apple seed is used, as stocks grown from these can resist more cold than those grown from the eastern and European seed. The seedlings are allowed to grow until their girth reaches that of a lead pencil, which generally takes one year, depending, however, on climate, length of season, and the kind of seed.

If root grafting is the method practiced, as is generally the case with nursery propagation of apple varieties, the seedlings are allowed to remain in the ground until late fall, so that their wood will be thoroughly ripened. Before the ground freezes, they are dug and healed in until early winter, *i. e.*, tied in bunches and the roots covered with earth and the tops with straw. Later, when the fall work slackens, they are taken up, sorted as to size, again tied in bunches and placed in a root-cellar, the roots being covered with sand or loose earth. Scions of the varieties one wishes to propagate are often gathered as needed, in countries where the winters are mild. In case the winters are severe, scions are cut, tied in bunches, and kept in the root-cellar, packed in straw or leaves. Only the last season's growth, or new wood, is used for scions, as this unites more easily than the older wood. Most of the grafting is done in winter, when the outside work is slack and both scion and stock are dormant. The grafter cuts his scion-wood into short pieces, makes the cuts as shown in *figure 1*, cuts off the top of a seedling, making the necessary cuts to receive the prepared scion, binds the two parts of the new baby tree tightly together with waxed cord, and packs them away

in sawdust or sandy earth until the spring planting season arrives. They are then planted six inches or more apart, in long rows, and after growing from two to four seasons, are carefully dug, sorted, tied in bunches and sold to the orchardist. When of of bearing age, they produce only fruit like the tree from which the scion-wood was taken.

The general character of the scion part of the tree is very rarely altered by the kind of stock it lives upon, except through the direct modifications caused by nourishment. For example, varieties of apples which grow to large-sized trees are dwarfed and bear earlier when grafted on Paradise apple stocks, because the stock is able to supply only enough raw food for a small tree. But why must one go to all this trouble, may be asked? Why not plant the seed of a Baldwin, just as one does with the seeds of garden plants? Surely red kidney beans always produce red kidney beans, and why will not Baldwins always produce Baldwins? If, however, a nurseryman planted Baldwin apple seed, he would probably find himself in possession of as many varieties of apples as he had seedlings, for most varieties of apples, plums, cherries and other fruit trees, like human beings, are hybrids, and do not breed true. They could be made to breed true from seed, if one cared to grow several generations of them and carefully and continually destroyed the rogues or off-type variations, so that they could not mix again with those trees that bore fruit true to type; but this would take a long time—in the case of apples perhaps from twelve to fifty years, for the average apple tree does not bear fruit until it is five to eight years old. From these facts, it is easy to see how impracticable such a slow method would be. Besides, grafted trees are said to bear fruit earlier and in greater quantity than ungrafted or seedling trees.

While root grafting (using the tongue or whip cuts) is probably one of the commonest forms this process takes in commercial practice, budding, which is essentially a form of grafting, is also extensively used, especially where the newly originated variety is in great demand and scion-wood is scarce and valuable. In most forms of grafting, the scion has more than one bud; while in budding, every healthy bud on the new wood can be used to produce a tree. Hence, by the latter practice, three or four trees can be secured from the same material from which, by the former, only one is usually secured. Of course, budding has many other advantages over ordinary grafting as well as many disadvantages, depending altogether on the varieties to be united, the climatic conditions and the price of labor. There is a third form of graft-

ing that one commonly meets which is of great importance commercially; *i.e.*, cleft-grafting. This method is particularly used when one desires to transform an old tree with poor fruit, or at least undesirable fruit, into one bearing good fruit. One may grow four or five hundred varieties of apple on a single tree by judicious cleft-grafting, or one may turn an old, sour crab-apple tree, growing by the roadside, into a tree filled with luscious apple fruit of the Jonathan type. Or perhaps there is a large wild bird cherry tree growing in one's yard, bearing great quantities of sour, seedy fruit. Why not change it into a tree bearing cluster upon cluster of luscious, sweet cherries, or of sour cherries of the type of Early Richmond or English Morello, such as one pays for at the rate of ten to fifteen cents a small basket in New York City? Space is all too brief here to give all the wonderful things that might be done by one expert in the knowledge of plant grafting.

Strange indeed have been the uses to which the principles underlying these methods have been put. They come still nearer home to us when we read of human lives saved through skin grafting and bone grafting. Our curiosity grows apace when we are told of grafted moths, short-lived monsters with two heads, double sets of wings and supernumerary pairs of legs; of brown rats grafted with tails from white rats, or even from mice; of angleworms with one head and two bodies or with one body and two heads. A rooster's spur has been taken from its normal position and planted in the rooster's comb, there to continue its growth. Different species of frogs, grafted together when very young, have lived to see the day when they could hop, their hind legs representing one species, while their front legs represented another.

But perhaps more marvellous than anything yet mentioned is the graft-hybrid,—an individual produced through grafting, which externally may resemble the scion parent and internally be like the stock parent, or *vice versa*. For centuries, gardeners have claimed such plants existed, but scientists were always skeptical concerning the statements made regarding their origin. Recently, however, Professor Winkler, of the Hamburg Botanic Garden, has been very successful in producing graft-hybrids between the common nightshade (*Solanum nigrum*) and the tomato, so that now there is no doubt about there being some truth in the century-old assertions concerning these graft-hybrids, prominent among which are the Bizzaria orange, the *Cytisus adami*, the white

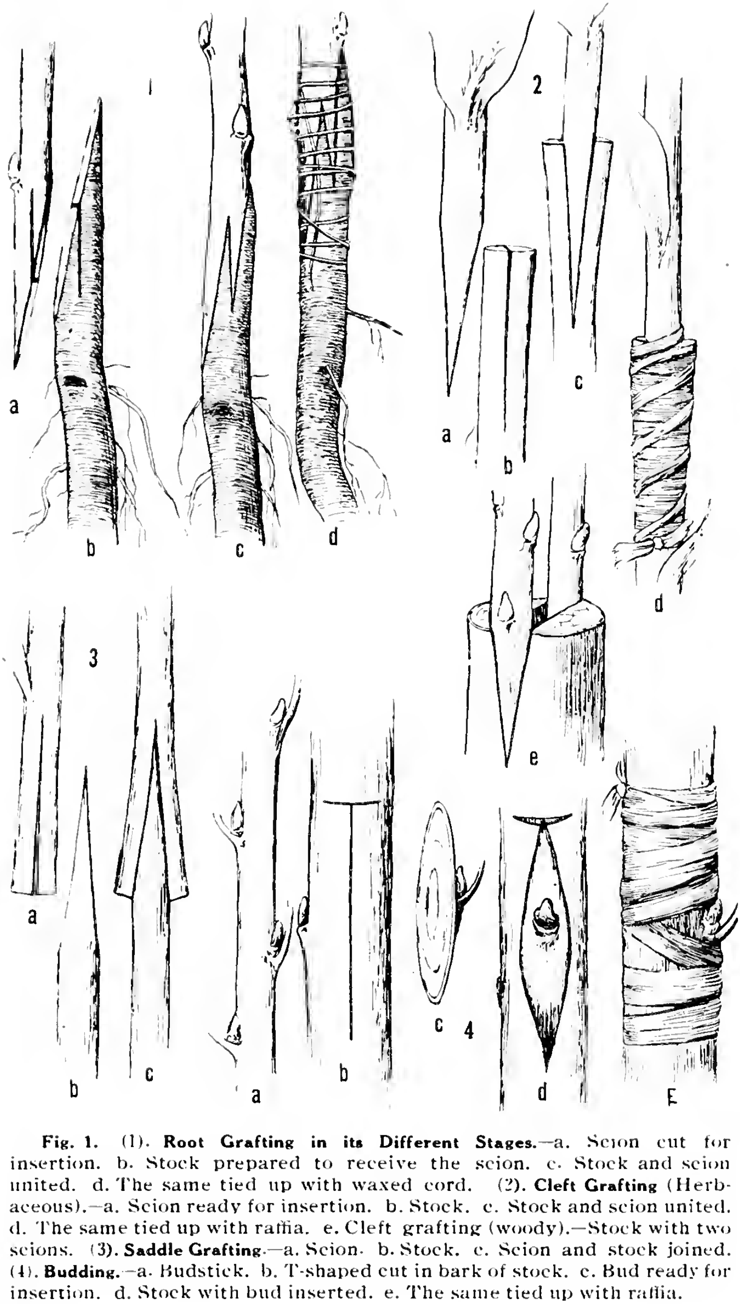

Fig. 1. (1). **Root Grafting in its Different Stages.**—a. Scion cut for insertion. b. Stock prepared to receive the scion. c. Stock and scion united. d. The same tied up with waxed cord. (2). **Cleft Grafting** (Herbaceous).—a. Scion ready for insertion. b. Stock. c. Stock and scion united. d. The same tied up with raffia. e. Cleft grafting (woody).—Stock with two scions. (3). **Saddle Grafting**.—a. Scion. b. Stock. c. Scion and stock joined. (4). **Budding.**—a. Budstick. b. T-shaped cut in bark of stock. c. Bud ready for insertion. d. Stock with bud inserted. e. The same tied up with raffia.

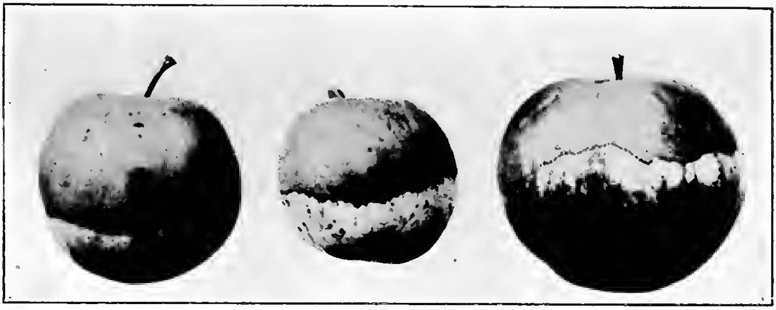

Fig. 2. Apple chimeras. Fruit said to be made up of two distinct varieties of apple—the Russet and the Boston Stripe. Note the line separating the two kinds of tissue. After Castle, in The Journal of Heredity.

Fig. 3. Different growth stages of a grafted frog embryo. The forepart of this embryo is one species of frog, while the hind part is another species. After Harrison.

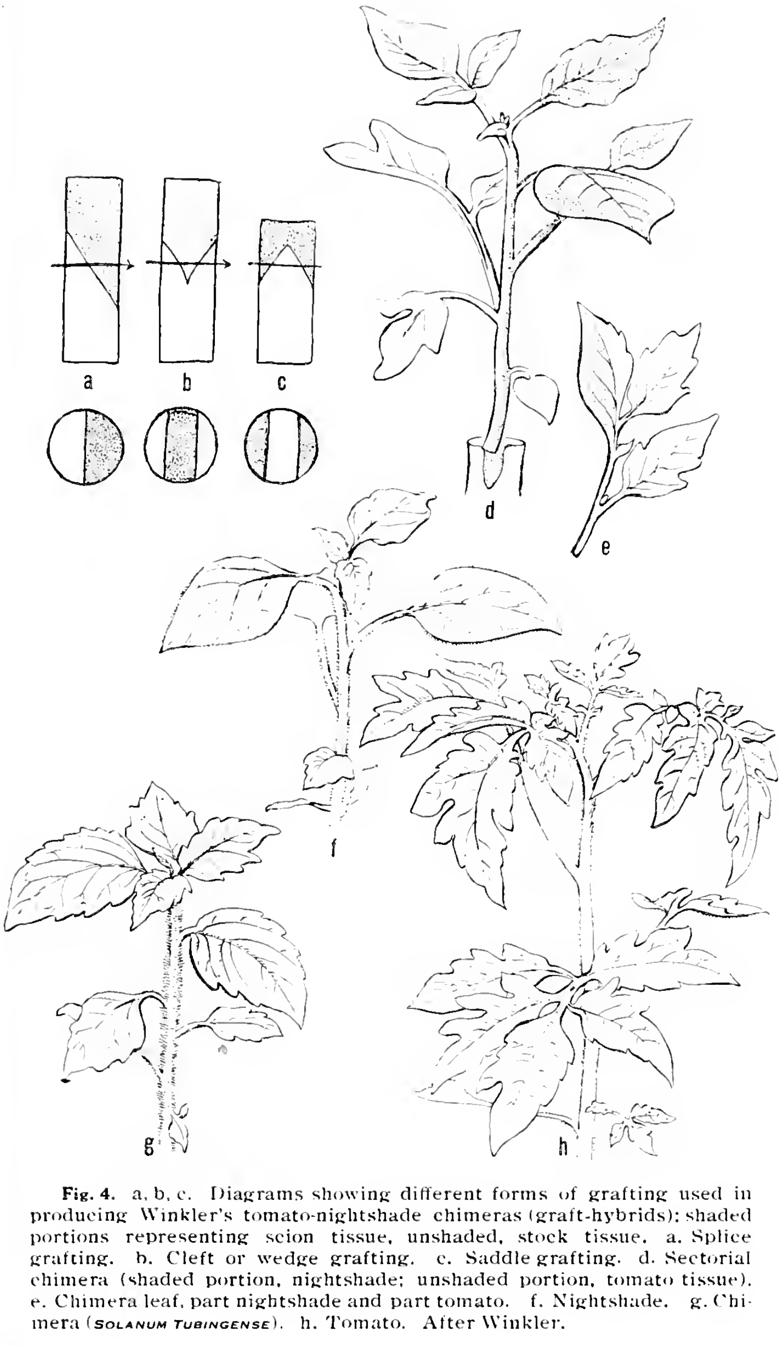

Fig. 4. a, b, c. Diagrams showing different forms of grafting used in producing Winkler's tomato-nightshade chimeras (graft-hybrids): shaded portions representing scion tissue, unshaded, stock tissue. a. Splice grafting. b. Cleft or wedge grafting. c. Saddle grafting. d. Sectorial chimera (shaded portion, nightshade; unshaded portion, tomato tissue). e. Chimera leaf, part nightshade and part tomato. f. Nightshade. g. Chimera (*Solanum tubingense*). h. Tomato. After Winkler.

(a) (b)

Fig. 5. Plants resulting from grafting together different plant species. a. Grafted plant composed of tomato (top), tobacco (center) and potato (stock). b. Grafted plant composed of tomato (top), potato (center) and tobacco (stock).

thorn-medlar and several freak apple trees. The first of these is said to have originated near Florence, Italy, about 1644, from the point of union in a graft between the orange and the citron. Some branches of this freak plant bore oranges, other branches bore citrons, while still other branches bore fruits part orange and part citron.

The apples illustrated in *figure 2* came from a tree in Nova Scotia, said to have originated from grafting together two varieties having differently colored fruits. Some apples on the tree are said to be like those from the scion, others are like the fruit the stock bore, while still other fruits represent a union of both varieties. The line of color demarcation is clearly shown in the photograph. When these mixed fruits were examined internally, each part had the characteristic flavor and texture of the variety to which its external color characters assigned it.

But it is from Dr. Winkler's careful work that the explanation of this phenomenon eventually came. Winkler's graft-hybrids or chimeras, as they are now more accurately called, were found to to be of four kinds, only one of which was truly a graft-hybrid, produced through the union of two cells. The other varieties are known as sectorial and periclinal chimeras, and all, including the true graft-hybrid, were produced through reciprocal grafting of scions and stocks of the tomato and nightshade. Cleft, saddle and splice grafts were made between these two markedly distinct forms, and as soon as the union between scion and stock was well established, a horizontal cut was made through the graft union, exposing the cut surface of both scion and stock tissue. When this surface healed over, buds arose. Those buds arising from either nightshade or tomato tissue resulted in pure nightshade or tomato branches, but those buds originating along the cut surfaces where scion and stock came together gave rise to chimeras and contained both nightshade and tomato tissue. Each tissue retained its own individuality, so that the product of such a union was a joint partnership of which hundreds of cells were nightshade and hundreds were tomato. There were no cells part nightshade and part tomato, except in the case of the true graft-hybrid mentioned earlier. In the sectorial or the simplest form of chimera, the respective areas of nightshade and tomato tissue were arranged in vertical planes, one side of the branch being pure nightshade, the other side pure tomato. Leaves arising from the boundary line between the two tissue areas were part nightshade and part tomato. Stems of such plants in cross section, showed areas of both sorts of tissue.

Solanum tubingense is a type of the periclinal chimera. Looking at it superficially, its characters appear to be intermediate between the two parent forms, but careful anatomical investigation demonstrated that internally it was pure nightshade with an external covering of pure tomato cells. Other forms obtained were found to be of the same character, while in still other intermediate forms, the tissue areas were reversed, the internal area being tomato with an external coat of nightshade. In some of the chimeras, the external coat was two layers of cells in thickness, while in others there was only one layer. When seeds from these intermediate or periclinal forms were planted, either pure tomato or pure nightshade plants resulted, depending altogether on the nature of the internal tissue. Hence, seeds of *Solanum tubingense* produced pure nightshade plants, while the forms with internal tissue areas of tomato covered with an external layer of nightshade produced pure tomato plants. Dr. Erwin Baur, of Berlin, first suggested the possibility of explaining Winkler's chimeras or graft-hybrids in this manner, as he had found in white-margined *Pelargonium* (*Geranium*) plants a somewhat similar state of affairs.

There is still one other interesting aspect of plant grafting to be considered—that of its bearing on plant genealogy. Can one unite apple scions with Norway maple stocks or roses with pine trees? Decidedly not! Theoretically, the nearer the relationship of scion and stock parent, the more successful the graft union. But how is one to determine this relationship? By taking the more or less superficial observations of the plant classificationists or the data from the crossing experiments as a guide? If the data from these sources are good criteria, why do some varieties of plants grow better on the roots of other varieties than they do on their own—as, for example, *Solanum nigrum erythrocarpum* on the roots of the tomato, or certain varieties of pear on the roots of quince. Horticulturists tell us this is true in these cases, even when both grafted and ungrafted plants are grown under equally favorable growth conditions. And again, if crossing is a good criterion of relationship, why do hawthorn trees and cotoneaster bushes, lilac shrubs and ash trees, tomato and tobacco plants, plum and peach trees graft together with a fair degree of facility, when, so far as our present evidence goes, they cannot be successfully crossed? From what has been said, it would seem that an absolutely safe criterion for establishing the degree of relationship between plants is lacking. Consequently

one must experiment to some extent in order to find out what plants will and what will not successfully unite through grafting. Of course, one is practically assured of success if one grafts only parts of a plant with other parts of the same plant, or even with its seedlings, but obviously such grafting would be of little practical value. Plants which cross, whether that signifies close genealogical relationship or not, usually form, when brought together as scion and stock, a fair graft union. However, if plants do not cross, there is still a possibility of successfully grafting or budding them, as the examples previously mentioned demonstrate.

Figure 5 is an illustration of such successful grafting between forms which have never been successfully crossed. Tomato, tobacco and the potato, according to some of our systematic friends, each belong to a separate genus of the same family, but there is no trouble about successfully grafting them with one another, as the plants from which the photographs were made (now in the greenhouse of the Brooklyn Botanic Garden) indisputably demonstrate. Strange, isn't it, that a potato and tomato can grow on a tobacco plant, get their nourishment through its roots, and never show a sign of such association in their external character or in the taste of their "fruits"!

O. E. W.

NOTICES

The Garden is open to the public daily, from 8 a. m. until sunset; on Sundays and holidays at 10 a. m. Conservatories open April 1–Oct. 1, 10 a. m.–4:30 p. m.; Oct. 1–April 1, 10 a. m.–4 p. m.

During the present season and until further notice, entrance to the Garden may be had only at the laboratory building on Washington Avenue, opposite Montgomery Street, on permission from the office. This temporary regulation is made necessary by extensive grading operations and the construction of new paths throughout the grounds.

The Garden may be reached by Flatbush Avenue trolley to Malbone Street; Franklin Avenue and Lorimer Street trolleys to Washington Avenue; St. John's Place trolley to Sterling Place; Ninth Avenue, Sixteenth Avenue, Union Street, Greenpoint and Smith Street trolleys to Prospect Park Plaza and Union Street, and Brighton Beach elevated to Consumers' Park Station. (The elevated train stops only when the conductor is notified in advance.)

A docent will meet parties by appointment and conduct them through the Garden.

Current numbers of LEAFLETS are free to all who wish them. Back series, complete, 50 cents each; single numbers, 5 cents each.

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